Contributed by R N Brackett

Jan. 12,

ANNUAL REPORTS

OF THE

DEPARTMENT OF THE INTERIOR

FOR THE

FISCAL YEAR ENDED JUNE 30, 1900.

TWENTY-FIRST ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY,

CHARLES D. WALCOTT, DIRECTOR.

PART VI—Continued.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

TWENTY-FIRST ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART VI (continued).—MINERAL RESOURCES OF THE UNITED STATES, 1899
NONMETALLIC PRODUCTS, EXCEPT COAL AND COKE

CONTENTS.

PETROLEUM, BY F. H. OLIPHANT.

NATURAL GAS, BY F. H. OLIPHANT.

ASPHALTUM AND BITUMINOUS ROCK, BY EDWARD W. PARKER.

STONE.

CLAY.

CLAY AND CLAY PRODUCTS AT THE PARIS EXPOSITION OF 1900, BY HEINRICH RIES.

ABRASIVE MATERIALS.

ILLUSTRATION.

PETROLEUM.[1]

By F. H. Oliphant.

IMPORTANT FEATURES OF THE YEAR.

The most conspicuous features in the petroleum developments of the United States for the past year were as follows: (1) The total quantity of crude petroleum produced in 1899 showed a considerable increase over that of 1898; (2) there was a large increase in the number of wells completed in both the Appalachian and the Lima-Indiana petroleum fields; (3) there was a large increase of crude petroleum produced in southeastern Ohio and a considerable increase in Texas in 1899 as compared with 1898; (4) only about 7 per cent of the total amount of petroleum produced in the United States came from outside of the Appalachian and the Lima-Indiana fields; (5) there was a decrease in the stocks of crude petroleum in the Lima-Indiana field and a slight gain in the stocks of the Appalachian field; (6) the price of crude petroleum at the wells was sharply advanced; (7) the export of petroleum decreased, but the increase in value made the receipts for 1899 over $12,000,000 greater than in 1898.

INCREASE IN TOTAL PRODUCTION OF THE UNITED STATES.

The total production of crude petroleum in the United States for 1899 was 57,070,850 barrels, of 42 gallons, as compared with 55,364,233 barrels in 1898 and 60,475,516 barrels in 1897. The increase during 1899 over the preceding year was 1,706,617 barrels or a little over 3 per cent. The production for 1896 was 60,960,361 barrels, the largest on record; 1897 was a close second, while 1899 is third and 1898 fourth in order.

INCREASE IN WELLS DRILLED IN 1899.

The total number of wells completed in the Appalachian and Lima-Indiana fields in 1899 was 13,368, and 2,418 of this number were dry; in 1898, 7,186 were drilled, and the dry holes numbered 1,539. There was an increase of 86 per cent in the total number of wells drilled in 1899 over 1898, while the gain in the number of dry holes was 56 per cent. As compared with 1897 the year 1898 showed a decrease of 16 per cent in the number of wells drilled and of 22 per cent in the dry holes.

[1] For much of the statistical information in this report credit should be given to the Oil City Derrick, and to Miss Belle Hill for the careful compilation of most of the tables. Other special acknowledgments are made in the body of the report.

INCREASE IN SOUTHEASTERN OHIO AND TEXAS.

The development of the Scio field in 1899 was a factor which made the production of southeastern Ohio 4,764,135 barrels in 1899 as compared with 2,147,610 barrels in 1898, an increase of 121.8 per cent. The new petroleum field at Corsicana, Texas, did not come up to the record of gain of new production recorded for 1898. The increase for 1899 was 122,943 barrels, amounting to 22½ per cent, as compared with a gain of 480,095 barrels in 1898 over 1897, equivalent to about 700 per cent.

PERCENTAGE OF PRODUCT BY FIELDS.

The following table shows the percentage of the Appalachian, the Lima-Indiana, and all other fields combined:

Percentages of total crude petroleum produced in the several fields for 1896, 1897, 1898, and 1899.

Field.	1896.	1897.	1898.	1899.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Appalachian	55.72	58.25	57.28	57.97
Lima-Indiana	41.43	37.71	36.70	35.48
All other	2.85	4.04	6.02	6.55
Total	100.00	100.00	100.00	100.00

There has been a slow but steady gain in the production of the oil fields outside of the Appalachian and Lima-Indiana territories since 1896, nearly 7 per cent of the total product in 1899 coming from Western and Southwestern sources. At this rate, however, many years will be required to wrest the supremacy from the Eastern fields.

DECREASE IN STOCKS.

The total stocks of petroleum held by the various pipe lines in the Appalachian and Lima-Indiana fields at the close of 1899 were 23,997,118 barrels, as compared with 26,967,495 barrels at the close of 1898 and 33,772,823 barrels at the close of 1897. The decrease in 1899 amounted to 2,970,377 barrels, or a little over 11 per cent. The decrease in 1898 was 6,805,328 barrels, or 20 per cent. The decrease in stocks in 1899 is due entirely to the shrinkage in the stocks of the Lima-Indiana districts, as the stocks in the Appalachian field made an increase of 1,664,588 barrels during the year. At the close of 1899 the Appalachian fields held 56 per cent of the total stocks of crude petroleum and the Lima-Indiana field 44 per cent, as compared with 40 per cent in the Appalachian field and 60 per cent in the Lima-Indiana field in 1898.

The net stocks of petroleum in iron tanks held by the various pipe lines at the close of 1898 and 1899 are given in the table that follows:

Stocks of petroleum held by pipe lines at the close of 1898 and 1899.

[Barrels of 42 gallons.]

Pipe-line.	December 31—	
	1898.	1899.
National Transit Co	5, 793, 997	7, 615, 626
Southwest Pipe Line Co	1, 192, 590	1, 560, 443
Eureka Pipe Line Co	1, 995, 464	1, 593, 080
Buckeye Pipe Line Co. (Macksburg oil)	556, 059	674, 583
Southern Pipe Line Co	456, 450	396, 256
Crescent Pipe Line Co	172, 677	73, 633
New York Transit Co	620, 982	756, 120
Tidewater Pipe Co	470, 174	294, 265
Producers and Refiners' Oil Co	230, 696	140, 966
Elk Oil Co	653	597
Emery Oil Co	23, 105	25, 102
United States Pipe Line Co	28, 906	33, 148
Other lines	244, 850	287, 372
Total stocks Appalachian field	11, 786, 603	13, 451, 191
Total Lima-Indiana stocks	15, 180, 892	10, 545, 927
Total both fields	26, 967, 495	23, 997, 118

It will be seen from the above that while the stocks in the Appalachian oil fields increased 1,664,588 barrels in 1899, the Lima-Indiana stocks declined 4,634,965 barrels, making a net decrease in both sections of 2,970,377 barrels.

INCREASE IN PRICES.

The average price per barrel of all the oil produced in the United States during 1899 was $1.1315, as compared with 79.8 cents in 1898 and 67.6 cents in 1897. The gain in price during the past year was 33.4 cents, or about 42 per cent. The production for 1899 was only 1,706,617 barrels in excess of that of 1898, but owing to the advanced prices the value of the product in 1899 was $20,410,545 greater than that of 1898. The average price of what is known as "Pennsylvania oil" (which includes about 95 per cent of the Appalachian output) was $1.29⅝ per barrel in 1899, as compared with 91¼ cents in 1898. This was an increase of 38¼ cents per barrel, or nearly 42 per cent. The average price of the Trenton rock oil of the Lima-Indiana districts was 88⅝ cents in 1899, as compared with 59.4 cents in 1898—an increase of 29.2 cents per barrel, equal to an advance of nearly 50 per cent. The prices ranged from 70.8 cents for Texas petroleum to $7 per barrel for Wyoming natural lubricating petroleum.

EXPORTS.

The total amount of petroleum and its products exported from the United States in 1899 was 951,024,441 gallons, valued at $64,982,249, as compared with 986,480,610 gallons, valued at $52,551,048, in 1898. A decrease of 35,456,169 gallons in amount was accompanied by a gain of $12,431,201 in value. While there was a decline of 3½ per cent in the amount of our petroleum exports, the increase in value was over 23 per cent. The total exports for 1897 were 994,297,757 gallons, valued at $59,057,547. Complete details of the petroleum exports will be found in another part of this report.

INCREASE IN THE APPALACHIAN FIELD.

This field embraces all the districts producing what is popularly known as "Pennsylvania oil." It extends from Wellsville, in New York State, on the northeast, down through western Pennsylvania into West Virginia, and includes a large portion of southeastern Ohio. Its extension through Kentucky and Tennessee into northern Alabama has not been attended with any noteworthy developments. The production of Kentucky and Tennessee has been very small, while Alabama has produced no oil in marketable quantities.

The total production of the Appalachian field for 1899 was 33,050,076 barrels, as compared with 31,711,857 barrels in 1898. The increase was 1,338,219 barrels, or 4.22 per cent. The greatest increase was in southeastern Ohio, where the output was more than doubled. The State of West Virginia made a gain of only a little over 2 per cent, while New York's gain was 9½ per cent. The only falling off was in Pennsylvania. The amount and percentage of increase and decrease in 1899 as compared with 1898, by States, is shown in the table that follows:

Production of petroleum in the Appalachian field in 1898 and 1899, by States, showing increase or decrease.

State.	Production.		Increase.	Decrease.	Percentage.	
	1898.	1899.			Increase.	Decrease.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Per cent.*	*Per cent.*
New York	1,205,250	1,320,909	115,659	....	9.596	....
Pennsylvania	14,743,214	13,053,603	....	1,689,611	....	11.46
West Virginia	13,615,101	13,910,630	295,529	....	2.17	....
Southeastern Ohio	2,148,292	4,764,934	2,616,642	....	121.8	....
Total	31,711,857	33,050,076	1,338,219	....	4.22	....

Pennsylvania is the only State where a decrease was shown during the past year. West Virginia's gain was very slight during 1899. In 1898 the increase in West Virginia was 4.01 and in 1897 30.6 per cent. For the past three years the production of this State has been maintained between 13,000,000 and 14,000,000 barrels, and the past year is the first that its yield has exceeded that of Pennsylvania.

DECREASE IN THE LIMA-INDIANA FIELD.

The Lima-Indiana field includes all of Indiana and that portion of northwestern Ohio in which Lima petroleum, found in the Trenton limestone, is produced. The production decreased from 20,321,323 barrels in 1898 to 20,225,356 barrels in 1899, a loss of 95,967 barrels, or less than one-half of 1 per cent. Of this total the fields of northwestern Ohio yielded 16,377,174 barrels in 1899, as compared with 16,590,416 barrels in 1898 and 18,682,677 barrels in 1897. While the northwestern Ohio yield of Lima crude declined 213,242 barrels during 1899, that of Indiana increased from 3,730,907 to 3,848,182, a gain of 117,275 barrels. In 1898 the production of the Lima-Indiana field declined about 12 per cent from the figures of 1897.

OTHER STATES.

Since 1894 Ohio has produced more petroleum than any other one State. During 1898 its two fields produced 40 per cent of the combined production of the Appalachian and Lima-Indiana fields. West Virginia now stands second in the order of States, displacing Pennsylvania, which is now third, with Indiana fourth, California fifth, New York sixth, and Texas seventh.

California gained 17.05 per cent in 1899 over that of 1898 as compared with a gain of 18.5 per cent in 1898 over that of 1897. Texas showed the largest gain of any State in 1899, but much less than the gain of 1898. In 1899 this gain amounted to 22.5 per cent over that of 1898, while 1898 showed a gain of 727.5 per cent over that of 1897. Colorado and Kansas both show a decrease, as well as Pennsylvania, when compared with the records for 1898.

Outside of Ohio, West Virginia, Pennsylvania, and New York only 3,795,418 barrels of crude petroleum were produced in 1899. Of this amount California produced nearly 70 per cent. The total production of California for 1899 was 2,642,095 barrels as against 2,257,207 barrels in 1898—an increase of 384,888 barrels.

Colorado and Kansas both show a decrease from their 1898 record. Colorado's production declined from 444,383 barrels in 1898 to 390,278 barrels in 1899, while the Kansas production was 71,980 barrels in 1898 and 69,700 barrels in 1899.

PRODUCTION AND VALUE.

TOTAL PRODUCTION AND VALUE.

In the following table is given a statement of the total amount and the total value of all crude petroleum produced in the United States in 1898 and 1899, by States and important districts:

Total amount and value of crude petroleum produced in the United States and average price per barrel in 1898 and 1899.

State and district.	1898.			1899.		
	Barrels.	Value.	Average value per barrel.	Barrels.	Value.	Average value per barrel.
California	2,257,207	$1,917,596	$0.85	2,642,095	$2,508,751	$0.95
Colorado	444,383	367,447	.82$\frac{7}{10}$	390,278	404,110	1.035
Illinois	360	1,800	5.00	360	1,800	5.00
Indiana	3,730,907	2,214,322	.59$\frac{2}{5}$	3,848,182	3,363,738	.874
Kansas	71,980	35,990	.50	69,700	52,275	.75
Kentucky	5,568	2,784	.50	18,280	17,256	.944
Michigan	0	0	0	132	205	1.55$\frac{1}{3}$
Missouri	10	105	10.50			
New York	1,205,250	1,098,284	.91$\frac{1}{8}$	1,320,909	1,708,926	1.29$\frac{3}{8}$
Ohio:						
Eastern and southern	2,147,610	1,957,010	.91$\frac{1}{8}$	4,764,135	6,243,075	1.31
Lima	16,590,416	10,244,582	.61$\frac{3}{4}$	16,377,174	14,718,985	.89$\frac{7}{8}$
Mecca-Belden	682	3,618	5.30$\frac{1}{2}$	799	4,244	5.31
Total	18,738,708	12,205,210	.65$\frac{1}{10}$	21,142,108	20,966,304	.9917
Pennsylvania:						
Franklin	56,090	224,360	4.00	61,085	244,340	4.00
Pennsylvania	14,684,944	13,381,655	.91$\frac{1}{8}$	12,991,368	16,807,582	1.29$\frac{3}{8}$
Smiths Ferry	2,180	1,987	.91$\frac{1}{8}$	1,150	1,488	1.29$\frac{3}{8}$
Total	14,743,214	13,608,002	.92$\frac{3}{10}$	13,053,603	17,053,410	1.306
Texas	546,070	277,135	.50$\frac{4}{5}$	669,013	473,443	.708
West Virginia:						
Burning Spr'gs West Virginia	13,603,136	12,395,858	.91$\frac{1}{8}$	13,892,906	17,973,947	1.29$\frac{3}{8}$
Petroleum *a* Volcano *b*	11,965	30,501	2.55	17,724	40,819	2.303
Total	13,615,101	12,426,359	.91$\frac{3}{10}$	13,910,630	18,014,766	1.29$\frac{1}{2}$
Wyoming	5,475	38,325	7.00	5,560	38,920	7.00
Grand total	*c*55,364,233	44,193,359	.79$\frac{4}{5}$	*c*57,070,850	64,603,904	1.13$\frac{1}{5}$

a Production of light oil in Petroleum included with West Virginia's product.

b Production of light oil in Volcano included with West Virginia's product.

c In addition to this product, 19,152 barrels of crude were produced in Kentucky and Tennessee in 1898 and 13,578 barrels in 1899 for which no value could be given, none being sold or used.

The increase or decrease in the production by States, as well as the percentages of increase or decrease in 1899 compared with 1898, is shown in the following table:

Total production of crude petroleum and percentage of increase or decrease, by States, in 1899 as compared with 1898.

State.	Production.		Increase in 1899.	Decrease in 1899.	Percentage.	
	1898.	1899.			Increase.	Decrease.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Per cent.*	*Per cent.*
California	2, 257, 207	2, 642, 095	384, 888		17. 05	
Colorado	444, 383	390, 278		54, 105		12. 18
Illinois	360	360				
Indiana	3, 730, 907	3, 848, 182	117, 275		3. 143	
Kansas	71, 980	69, 700		2, 280		3. 1675
Kentucky	5, 568	18, 280	12, 712		228. 30	
Michigan	0	132	122		1,220.00	
Missouri	10					
New York	1, 205, 250	1, 320, 909	115, 659		9. 596	
Ohio	18, 738, 708	21, 142, 108	2, 403, 400		12. 826	
Pennsylvania	14, 743, 214	13, 053, 603		1, 689, 611		11. 46
Texas	546, 070	669, 013	122, 943		22. 514	
West Virginia	13, 615, 101	13, 910, 630	295, 529		2. 17	
Wyoming	5, 475	5, 560	85		1. 55	
Total	55, 364, 233	57, 070, 850	1, 706, 617		3. 082	

It will be noted in the above table that, while the percentages of increase and decrease vary largely in the several States, there is a total gain in the production of 3.082 per cent. Of the most important of the oil-producing States Texas shows the largest percentage of increase and Colorado the greatest decline. While Kentucky increased its output over 200 per cent, the total yield of the State is a very small proportion of the whole, being partially the accumulation of former years and brought to market by the completion of a pipe line.

PRODUCTION BY FIELDS.

The production of petroleum in the principal fields of the United States in 1896, 1897, 1898, and 1899 was as follows:

Production of petroleum in the United States in 1896, 1897, 1898, and 1899, by fields.

[Barrels of 42 gallons.]

Field.	Production.			
	1896.	1897.	1898.	1899.
Appalachian	33,970,222	35,229,949	31,711,857	33,050,076
Lima-Indiana	25,255,870	22,805,033	20,321,323	20,225,356
Southern California	1,252,777	1,903,411	2,257,207	2,642,095
Florence, Colorado	361,450	384,934	444,383	390,278
Kansas	113,571	81,098	71,980	69,700
Texas	1,450	65,975	546,070	669,013
Wyoming	2,878	3,650	5,475	5,560
Other	2,143	1,466	5,938	18,772
Total	*a* 60,960,361	*a* 60,475,516	*a* 55,364,233	*a* 57,070,850

a In addition to this amount, 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,152 barrels in 1898, and 13,578 barrels in 1899, for which, as none was sold or used, no value could be given.

PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES, 1859 TO 1899.

In the following table will be found a statement of the production of crude petroleum in the United States from the beginning of production, marked by the drilling of the Colonel Drake well in 1859, up to and including the production of 1899, the tables being by years and States:

Production of crude petroleum in the United States from 1859 to 1899.

[Barrels of 42 gallons.]

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.
1859	2,000						
1860	500,000						
1861	2,113,609						
1862	3,056,690						
1863	2,611,309						
1864	2,116,109						
1865	2,497,700						
1866	3,597,700						

Production of crude petroleum in the United States from 1859 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.
1867.	3,347,300	....	....	....	....	....	....
1868.	3,646,117	....	....	....	....	....	....
1869.	4,215,000	....	....	....	....	....	....
1870.	5,260,745	....	....	....	....	....	....
1871.	5,205,234	....	....	....	....	....	....
1872.	6,293,194	....	....	....	....	....	....
1873.	9,893,786	....	....	....	....	....	....
1874.	10,926,945	....	....	....	....	....	....
1875.	8,787,514	*a* 200,000	*a* 3,000,000	*a* 175,000	....	....	....
1876.	8,968,906	31,763	120,000	12,000	....	....	....
1877.	13,135,475	29,888	172,000	13,000	....	....	....
1878.	15,163,462	38,179	180,000	15,227	....	....	....
1879.	19,685,176	29,112	180,000	19,858	....	....	....
1880.	26,027,631	38,940	179,000	40,552	....	....	....
1881.	27,376,509	33,867	151,000	99,862	....	....	....
1882.	30,053,500	39,761	128,000	128,636	*b* 160,933	....	....
1883.	23,128,389	47,632	126,000	142,857	4,755	....	....
1884.	23,772,209	90,081	90,000	262,000	4,148	....	....
1885.	20,776,041	661,580	91,000	325,000	5,164	....	....
1886.	25,798,000	1,782,970	102,000	377,145	4,726	....	....
1887.	22,356,193	5,022,632	145,000	678,572	4,791	76,295	....
1888.	16,488,668	10,010,868	119,448	690,333	5,096	297,612	....
1889.	21,487,435	12,471,466	544,113	303,220	5,400	316,476	33,375
1890.	28,458,208	16,124,656	492,578	307,360	6,000	368,842	63,496
1891.	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634
1892.	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	698,068
1893.	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293
1894.	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666
1895.	19,144,390	19,545,233	8,120,125	1,208,482	1,500	438,232	4,386,132
1896.	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732
1897.	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356
1898.	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907
1899.	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182
Total.	586,826,723	218,726,273	87,815,150	14,739,391	248,363	5,678,120	27,723,841

a Including all productions prior to 1876.

b This includes all the petroleum produced in Kentucky and Tennessee prior to 1883.

Production of crude petroleum in the United States from 1859 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	Illinois.	Kansas.	Texas.	Missouri.	Indian Territory.	Wyoming.	United States.
1859	....	....	....	....	....	....	2,000
1860	....	....	....	....	....	....	500,000
1861	....	....	....	....	....	....	2,113,609
1862	....	....	....	....	....	....	*a* 3,056,690
1863	....	....	....	....	....	....	2,611,309
1864	....	....	....	....	....	....	2,116,109
1865	....	....	....	....	....	....	2,497,700
1866	....	....	....	....	....	....	3,597,700
1867	....	....	....	....	....	....	3,347,300
1868	....	....	....	....	....	....	3,646,117
1869	....	....	....	....	....	....	4,215,000
1870	....	....	....	....	....	....	5,260,745
1871	....	....	....	....	....	....	5,205,234
1872	....	....	....	....	....	....	6,293,194
1873	....	....	....	....	....	....	9,893,786
1874	....	....	....	....	....	....	10,926,945
1875	....	....	....	....	....	....	*b* 12,162,514
1876	....	....	....	....	....	....	9,132,669
1877	....	....	....	....	....	....	13,350,363
1878	....	....	....	....	....	....	15,396,868
1879	....	....	....	....	....	....	19,914,146
1880	....	....	....	....	....	....	26,286,123
1881	....	....	....	....	....	....	27,661,238
1882	....	....	....	....	....	....	30,510,830
1883	....	....	....	....	....	....	23,449,633
1884	....	....	....	....	....	....	24,218,438
1885	....	....	....	....	....	....	21,858,785
1886	....	....	....	....	....	....	28,064,841
1887	....	....	....	....	....	....	28,283,483
1888	....	....	....	....	....	....	27,612,025
1889	1,460	500	48	20	....	....	35,163,513
1890	900	1,200	54	278	....	....	45,823,572
1891	675	1,400	54	25	30	....	54,292,655
1892	521	....	45	10	80	....	50,509,657

a In addition to this amount, it is estimated that for want of a market some 10,000,000 barrels ran to waste in and prior to 1862 from the Pennsylvania fields; also a large amount from West Virginia and Tennessee.

b Including all production prior to 1876 in Ohio, West Virginia, and California.

Production of crude petroleum in the United States from 1859 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	Illinois.	Kansas.	Texas.	Missouri.	Indian Territory.	Wyoming.	United States.
1893	400	18,000	50	50	10	....	48,431,066
1894	300	40,000	60	8	130	2,369	49,344,516
1895	200	44,430	50	10	37	3,455	52,892,276
1896	250	113,571	1,450	43	170	2,878	*a* 60,960,361
1897	500	81,098	65,975	19	625	3,650	*a* 60,475,516
1898	360	71,980	546,070	10	0	5,475	*a* 55,364,233
1899	360	69,700	669,013	*b* 132	....	5,560	*a* 57,070,850
Total	5,926	441,879	1,282,869	605	1,082	23,387	*a* 943,513,609

a In addition to this amount, 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,152 barrels in 1898, and 13,578 barrels in 1899, for which, as none was sold or used, no value could be given.

b Includes the production of Michigan.

From the foregoing table it appears that the total production of crude petroleum in the United States during the past forty years has reached the enormous amount of 943,513,609 barrels. If we allow 5.6 cubic feet to one barrel of petroleum, this amount of oil would fill a space equivalent to 5,283,676,210.4 cubic feet. The sides of a cube to contain this volume of oil would have to be 1,741.7 feet in length. This amount of oil would fill a tank with a base of 1 square mile to a height of 189 feet. It would fill 31,450 iron tanks of 30,000 barrels capacity, and these tanks, touching side to side and placed in a straight line, would extend a distance of nearly 480 miles.

Of this great total, Pennsylvania has furnished 62 per cent; Ohio, 23 per cent; West Virginia, 9.3 per cent; Indiana, 3 per cent, and California, 1.5 per cent, leaving 1.2 per cent to be furnished by the other States producing petroleum.

For convenience of reference, a statement is given below of the production of petroleum in the United States from 1892 to 1899, by States:

Production of petroleum in the United States from 1892 to 1899, by States.

[Barrels of 42 gallons.]

State.	1892.	1893.	1894.	1895.
California	385,049	470,179	705,969	1,208,482
Colorado	824,000	594,390	515,746	438,232
Illinois	521	400	300	200
Indiana	698,068	2,335,293	3,688,666	4,386,132
Indian Territory	80	10	130	37
Kansas	....	18,000	40,000	44,430
Kentucky	6,500	3,000	1,500	1,500
Missouri	10	50	8	10
New York	1,273,343	1,031,391	942,431	912,948
Ohio	16,362,921	16,249,769	16,792,154	19,545,233
Pennsylvania	27,149,034	19,283,122	18,077,559	18,231,442
Texas	45	50	60	50
West Virginia	3,810,086	8,445,412	8,577,624	8,120,125
Wyoming	....	....	2,369	3,455
Total	50,509,657	48,431,066	49,344,516	52,892,276

State.	1896.	1897.	1898.	1899.
California	1,252,777	1,903,411	2,257,207	2,642,095
Colorado	361,450	384,934	444,383	390,278
Illinois	250	500	360	360
Indiana	4,680,732	4,122,356	3,730,907	3,848,182
Indian Territory	170	625	0	0
Kansas	113,571	81,098	71,980	69,700
Kentucky	1,680	322	5,568	18,280
Michigan	....	....	....	132
Missouri	43	19	10	
New York	1,205,220	1,279,155	1,205,250	1,320,909
Ohio	23,941,169	21,560,515	18,738,708	21,142,108
Pennsylvania	19,379,201	17,982,911	14,743,214	13,053,603
Texas	1,450	65,975	546,070	669,013
West Virginia	10,019,770	13,090,045	13,615,101	13,910,630
Wyoming	2,878	3,650	5,475	5,560
Total	*a*60,960,361	*a*60,475,516	*a*55,364,233	*a*57,070,850

a In addition to this amount, 4,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,152 barrels in 1898, and 13,578 barrels in 1899, for which, as none was sold or used, no value could be given.

EXPORTS.

The following tables are the official statement of the export of petroleum and its products (mineral oils) for the year ending December 31, 1899, as compared with the preceding year:

Exports of mineral oils from the United States in 1898 and 1899.

Port and kind.	1898.		1899.	
	Gallons.	Value.	Gallons.	Value.
CRUDE.				
Delaware	62,540,629	$2,390,650	71,206,551	$3,432,458
New York	2,653,940	130,850	3,622,195	262,385
Philadelphia	49,720,513	2,242,611	42,855,221	2,262,986
Total	114,915,082	4,764,111	117,683,967	5,957,829
NAPHTHAS.				
Boston and Charlestown	....	....	1,538	404
Delaware	1,616,402	88,410	1,752,824	110,049
New York	8,271,719	540,339	9,563,127	968,591
Philadelphia	7,138,505	424,482	6,586,526	478,563
Total	17,026,626	1,053,231	17,904,015	1,557,607
ILLUMINATING.				
Baltimore	45,278,794	2,728,019	38,354,499	2,383,517
Boston and Charlestown	687,357	52,565	848,076	71,038
Delaware	23,970,772	909,021	20,905,323	1,201,042
New York	498,513,494	26,471,434	470,569,568	32,635,754
Philadelphia	192,701,690	8,381,043	193,885,527	12,174,849
Total	761,152,107	38,542,082	724,562,993	48,466,200
LUBRICATING AND PARAFFIN.				
Baltimore	989,568	121,538	858,336	108,253
Boston and Charlestown	148,860	28,358	455,804	83,988
New York	49,816,219	6,195,803	55,872,621	7,078,330
Philadelphia	13,013,694	1,039,355	12,142,427	1,074,164
Total	63,968,341	7,385,054	69,329,188	8,344,735

Exports of mineral oils from the United States in 1898 and 1899—Continued.

Port and kind.	1898.		1899.	
	Gallons.	Value.	Gallons.	Value.
RESIDUUM.				
Boston and Charlestown			22,680	$1,614
Delaware	42	$3		
New York	13,708,800	329,007	7,258,692	227,924
Philadelphia	15,709,612	477,560	14,262,906	426,340
Total	29,418,454	806,570	21,544,278	655,878
RECAPITULATION BY KINDS.				
Crude petroleum	114,915,082	$4,764,111	117,683,967	$5,957,829
Naphtha	17,026,626	1,053,231	17,904,015	1,557,607
Illuminating oil	761,152,107	38,542,082	724,562,993	48,466,200
Lubricating oil and paraffin	63,968,341	7,385,054	69,329,188	8,344,735
Residuum	29,418,454	806,570	21,544,278	655,878
Total	986,480,610	52,551,048	951,024,441	64,982,249
RECAPITULATION BY PORTS.				
Baltimore	46,268,362	2,849,557	39,212,835	2,491,770
Boston and Charlestown	836,217	80,923	1,328,098	157,044
Delaware	88,127,845	3,388,084	93,864,698	4,743,549
New York	572,964,172	33,667,433	546,886,203	41,172,984
Philadelphia	278,284,014	12,565,051	269,732,607	16,416,902
Grand total	986,480,610	52,551,048	951,024,441	64,982,249

Exports of mineral oils from the United States from 1887 to 1899, inclusive.

[Gallons.]

Year.	Crude.	Naphthas.	Illuminating.	Lubricating and paraffin.	Residuum.	Total.	
						Quantity.	Value.
1887...	80, 643, 839	12, 344, 669	464, 702, 903	20, 340, 820	2, 989, 098	581, 021, 329	$45, 231, 988
1888...	77, 387, 799	13, 466, 234	450, 801, 683	24, 280, 826	1, 861, 104	567, 797, 646	47, 563, 749
1889...	84, 144, 196	13, 958, 985	548, 496, 241	27, 754, 239	1, 837, 794	676, 191, 455	52, 792, 473
1890...	95, 368, 525	12, 406, 586	547, 542, 569	31, 896, 146	1, 828, 900	689, 042, 726	51, 657, 302
1891...	94, 926, 424	11, 398, 085	526, 972, 018	33, 068, 716	932, 692	667, 297, 935	45, 351, 957
1892...	104, 012, 829	16, 351, 340	586, 406, 366	33, 805, 128	329, 574	740, 905, 237	42, 283, 163
1893...	114, 609, 343	16, 249, 389	705, 674, 917	34, 762, 754	460, 614	871, 757, 017	41, 117, 814
1894...	114, 268, 611	14, 831, 967	726, 726, 687	38, 975, 128	59, 766	894, 862, 159	40, 463, 088
1895...	115, 954, 128	12, 757, 940	677, 500, 647	46, 769, 565	143, 850	853, 126, 130	56, 223, 425
1896...	117, 921, 276	13, 420, 769	749, 305, 844	50, 629, 143	507, 990	931, 785, 022	62, 764, 278
1897...	121, 488, 726	13, 430, 320	795, 919, 525	51, 228, 284	12, 230, 902	994, 297, 757	59, 057, 547
1898...	114, 915, 082	17, 026, 626	761, 152, 107	63, 968, 341	29, 418, 454	986, 480, 610	52, 551, 048
1899...	117, 683, 967	17, 904, 015	724, 562, 993	69. 329, 188	21, 544, 278	951, 024, 441	64, 982, 249

This table is of interest as showing the remarkably steady amount of illuminating oil that has been marketed during the last few years. It also shows the increasing demand for the other products of crude petroleum, as well as for the crude itself. Compare the year 1894 with 1899; the amount of illuminating oil is very nearly the same, yet the sales of other products and of crude have largely increased.

Exports of mineral oil from the United States in years 1896 to 1899, by months.

Month.	1896.		1897.	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*
January	77, 686, 921	5, 377, 562	61, 006, 066	4, 081, 845
February	57, 963, 088	3, 975, 059	72, 378, 443	4, 561, 148
March	64, 260, 114	4, 359, 244	78, 622, 541	4, 884, 479
April	65, 997, 339	4, 773, 256	68, 434, 629	4, 046, 766
May	84, 562, 853	5, 849, 489	84, 714, 994	5, 362, 282
June	79, 116, 959	5, 288, 296	96, 569, 600	5, 655, 793
July	83, 296, 885	5, 498, 741	89, 083, 369	5, 132, 815
August	88, 055, 592	5, 618, 276	94, 763, 463	5, 691, 276
September	80, 942, 500	5, 491, 190	87, 413, 316	4, 850, 891
October	92, 252, 141	6, 094, 163	87, 843, 419	4, 960, 228
November	71, 297, 467	4, 807, 147	82, 676, 014	4, 964, 730
December	86, 353, 163	5, 631, 855	90, 791, 903	4, 865, 294
Total 12 months...	931, 785, 022	62, 764, 278	994, 297, 757	59, 057, 547

Exports of mineral oil from the United States from 1896 to 1899, by months—Continued.

Month.	1898.		1899.	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*
January	85, 412, 917	3, 989, 811	62, 385, 776	3, 817, 129
February	62, 091, 132	2, 998, 714	51, 759, 280	3, 403, 331
March	85, 944, 541	4, 243, 945	85, 273, 703	5, 291, 534
April	76, 649, 229	3, 929, 149	66, 873, 657	4, 267, 075
May	86, 431, 145	4, 571, 862	87, 216, 379	5, 210, 928
June	93, 109, 931	4, 972, 286	87, 214, 749	5, 481, 991
July	89, 982, 205	4, 722, 093	81, 171, 542	5, 245, 519
August	97, 457, 340	5, 010, 507	100, 220, 318	6, 565, 691
September	87, 999, 604	4, 779, 026	92, 676, 402	7, 007, 626
October	79, 524, 827	4, 643, 148	86, 562, 810	6, 583, 145
November	76, 007, 690	4, 496, 250	83, 678, 752	6, 632, 253
December	65, 870, 049	4, 194, 257	65, 991, 073	5, 476, 027
Total 12 months	986, 480, 610	52, 551, 048	951, 024, 441	64, 982, 249

The average distillation of 100 gallons of crude petroleum is estimated to yied 76 gallons of illuminating oil, 11 gallons of gasoline, benzine, and naphtha, 3 gallons of lubricating oil, and 10 gallons of residuum and loss.

In the following table are given the exports of crude petroleum and its products from the United States from 1871 to 1899, together with a statement of the production of the United States in the years named, reduced to gallons. From these figures it appears that about 43 per cent of the total marketable products derived from the petroleum produced in the United States finds a market abroad. The figures of exports are from the Statistical Abstracts of the United States, published by the Bureau of Statistics, Treasury Department. The figures of production were collected by the writer and other agents of the Geological Survey.

Quantity of crude petroleum produced in, and the qualities and values of petroleum products exported from, the United States during each of the calendar years from 1871 to 1899.

Year ending December 31—	Production.		Exports.			
	Barrels (of 42 gallons).	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Mineral, refined or manufactured. Naphthas, benzine, gasoline, etc.	
			Gallons.	*Dollars.*	*Gallons.*	*Dollars.*
1871..	5, 205, 234	218, 619, 828	11, 278, 589	2, 171, 706	8, 396, 905	895, 910
1872..	6, 293, 194	264, 314, 148	16, 363, 975	2, 761, 094	8, 688, 257	1, 307, 058
1873..	9, 893, 786	415, 539, 012	19, 643, 740	2, 665, 171	10, 250, 497	1, 266, 962
1874..	10, 926, 945	458, 931, 690	14, 430, 851	1, 428, 494	10, 616, 644	997, 355
1875..	12, 162, 514	510, 825, 588	16, 536, 800	1, 738, 589	14, 048, 726	1, 392, 192
1876..	9, 132, 669	383, 572, 098	25, 343, 271	3, 343, 763	13, 252, 751	1, 502, 498
1877..	13, 350, 363	560, 715, 246	28, 773, 233	3, 267, 309	19, 565, 909	1, 938, 672
1878..	15, 396, 868	646, 668, 456	24, 049, 604	2, 169, 790	13, 431, 782	1, 077, 402
1879..	19, 914, 146	836, 394, 132	28, 601, 650	2, 069, 458	19, 524, 582	1, 367, 996
1880..	26, 286, 123	1, 104, 017, 166	36, 748, 116	2, 772, 400	15, 115, 131	1, 344, 529
1881..	27, 661, 238	1, 161, 771, 996	40, 430, 108	3, 089, 297	20, 655, 116	1, 981, 197
1882..	30, 510, 830	1, 281, 454, 860	45, 011, 154	3, 373, 302	16, 969, 839	1, 304, 041
1883..	23, 449, 633	984, 884, 586	59, 018, 537	4, 439, 097	17, 365, 314	1, 195, 035
1884..	24, 218, 438	1, 017, 174, 396	79, 679, 395	6, 102, 810	13, 676, 421	1, 132, 528
1885..	21, 858, 785	918, 068, 970	81, 435, 609	6, 040, 685	14, 739, 469	1, 160, 999
1886..	28, 064, 841	1, 178, 723, 322	76, 346, 480	5, 068, 409	14, 474, 951	1, 264, 736
1887..	28, 283, 483	1, 187, 906, 286	80, 650, 286	5, 141, 833	12, 382, 213	1, 049, 043
1888..	27, 612, 025	1, 159, 705, 050	77, 549, 452	5, 454, 705	13, 481, 706	1, 083, 429
1889..	35, 163, 513	1, 476, 867, 546	85, 189, 658	6, 134, 002	13, 984, 407	1, 208, 116
1890..	45, 822, 672	1, 924, 552, 224	96, 572, 625	6, 535, 499	12, 462, 636	1, 050, 613
1891..	54, 291, 980	2, 280, 263, 160	96, 722, 807	5, 365, 579	11, 424, 993	868, 137
1892..	50, 509, 136	2, 121, 383, 712	104, 397, 107	4, 696, 191	16, 393, 284	1, 037, 558
1893*a*.	48, 412, 666	2, 033, 331, 972	111, 703, 508	4, 567, 391	17, 304, 005	1, 074, 710
1894..	49, 344, 516	2, 072, 469, 672	121, 926, 349	4, 415, 915	15, 555, 754	943, 970
1895..	52, 892, 276	2, 221, 475, 592	111, 285, 264	5, 161, 710	14, 801, 224	910, 988
1896..	*b*60, 960, 361	2, 560, 335, 162	110, 923, 620	6, 121, 836	12, 349, 319	1, 059, 542
1897..	*b*60, 475, 516	2, 539, 971, 672	121, 488, 726	5, 020, 968	13, 430, 320	994, 781
1898..	*b*55, 364, 233	2, 325, 297, 786	114, 915, 082	4, 764, 111	17, 026, 626	1, 053, 231
1899..	*b*57, 070, 850	2, 396, 975, 700	117, 683, 967	5, 957, 829	17, 904, 015	1, 557, 607

a Exports are for fiscal years from 1893 to 1896, inclusive.

b In addition to this amount, 1,325 barrels of crude oil were produced in Kentucky and Tennessee in 1896, 4,377 barrels in 1897, 19,152 barrels in 1898, and 13,578 barrels in 1899, for which, as none was sold or used, no value could be given.

Quantity of crude petroleum produced in, and the qualities and values of petroleum products exported from, the United States, etc.—Continued.

Year ending December 31—	Exports.			
	Mineral, refined or manufactured.			
	Illuminating.		Lubricating (heavy paraffin, etc.).	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*
1871	132, 178, 843	33, 493, 351	240, 228	92, 408
1872	118, 259, 832	29, 456, 453	438, 425	180, 462
1873	207, 595, 988	41, 357, 686	1, 502, 503	517, 466
1874	206, 562, 977	30, 168, 747	993, 068	269, 886
1875	203, 678, 748	28, 168, 572	938, 052	265, 837
1876	220, 831, 608	44, 089, 066	1, 157, 929	370, 431
1877	307, 373, 842	51, 366, 205	1, 914, 129	577, 610
1878	306, 212, 506	36, 855, 798	2, 525, 545	698, 182
1879	365, 597, 467	32, 811, 755	3, 168, 561	713, 208
1880	286, 131, 557	29, 047, 908	5, 607, 009	1, 141, 825
1881	444, 666, 615	42, 122, 683	5, 053, 862	1, 165, 605
1882	428, 424, 581	37, 635, 981	8, 821, 536	2, 034, 487
1883	440, 150, 660	39, 470, 352	10, 108, 394	2, 193, 245
1884	433, 851, 275	39, 450, 794	11, 985, 219	2, 443, 385
1885	445, 880, 518	39, 476, 082	12, 978, 955	2, 659, 210
1886	485, 120, 680	39, 012, 922	13, 948, 367	2, 689, 464
1887	485, 242, 107	37, 007, 336	20, 582, 613	3, 559, 280
1888	455, 045, 784	37, 236, 111	24, 510, 437	4, 215, 449
1889	551, 769, 666	41, 215, 192	27, 903, 267	4, 638, 724
1890	550, 873, 438	39, 826, 086	32, 090, 537	4, 766, 850
1891	531, 445, 099	34, 879, 759	33, 310, 264	4, 999, 978
1892	589, 418, 185	31, 826, 545	34, 026, 855	5, 130, 643
1893 *a*	642, 239, 816	31, 719, 404	32, 432, 857	4, 738, 892
1894	730, 368, 626	30, 676, 217	40, 190, 577	5, 449, 000
1895	714, 859, 144	34, 706, 844	43, 418, 942	5, 867, 477
1896	716, 455, 565	48, 630, 920	50, 525, 530	6, 556, 775
1897	795, 919, 525	46, 229, 579	51, 228, 284	6, 478, 479
1898	761, 152, 107	38, 542, 082	63, 968, 341	7, 385, 054
1899	724, 562, 993	48, 466, 200	69, 329, 188	8, 344, 735

a Exports are for fiscal years from 1893 to 1896, inclusive.

Quantity of crude petroleum produced in, and the qualities and values of petroleum products exported from, the United States, etc.—Continued.

Year ending December 31—	Exports.			
	Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total.	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*
1871	101,052	10,450	152,195,617	36,663,825
1872	568,218	56,618	144,318,707	33,761,685
1873	1,377,180	117,595	240,369,908	45,924,880
1874	2,504,628	177,794	235,108,168	33,042,276
1875	2,323,986	169,671	237,526,312	31,734,861
1876	2,863,896	239,461	263,449,455	49,545,219
1877	4,256,112	390,077	361,883,225	57,539,873
1878	3,126,816	220,835	349,346,253	41,022,007
1879	4,827,522	273,050	421,719,782	37,235,467
1880	3,177,630	198,983	346,779,443	34,505,645
1881	3,756,018	197,321	514,561,719	48,556,103
1882	4,265,352	275,263	503,492,462	44,623,074
1883	6,502,524	465,350	533,145,429	47,763,079
1884	5,303,298	327,599	544,495,608	49,457,116
1885	5,713,908	334,767	560,784,459	49,671,743
1886	1,993,824	109,673	591,884,302	48,145,204
1887	2,989,098	141,350	601,846,317	46,898,842
1888	1,870,596	116,009	572,457,975	48,105,703
1889	1,858,458	97,265	680,705,456	53,293,299
1890	1,830,612	91,905	693,829,848	52,270,953
1891	1,002,414	61,382	673,905,577	46,174,835
1892	403,032	38,220	744,638,463	42,729,157
1893 [a]	541,044	41,661	804,221,230	42,142,058
1894	211,008	14,704	908,252,314	41,499,806
1895	137,508	13,063	884,502,082	46,660,082
1896	204,960	14,330	890,458,994	62,383,403
1897	12,230,902	333,740	994,297,757	59,057,547
1898	29,418,454	806,570	986,480,610	52,551,048
1899	21,544,278	655,878	951,024,441	64,982,249

[a] Exports are for fiscal years from 1893 to 1896, inclusive.

PETROLEUM TANK STEAMERS.

The number of tank steamers carrying petroleum in bulk is steadily increasing from year to year. There were eight of these vessels constructed during 1899, with a total tonnage capacity of 31,447 tons. In

only four instances in the history of the tank-steamer trade have larger totals been registered. These were: 1888, when 18 vessels were constructed, with a total gross tonnage of 42,047; in 1889, 14 vessels, of 36,495 tons; 1893, with 94,568 tons; 1894, 34,721 tons. Compared with 1898 the tonnage of 1899 shows an increased construction amounting to 20,539 tons. The details of the eight vessels turned out from the yards during the past year were as follows:

Tank steamers built in 1899.

Vessels.	Tons.	Built for—
Caucasian	4,400	Lane & Macandrew (Caucasian Steamship Co.).
Lucifer	3,832	Bowring & Co. (Bear Creek Oil Co.).
Bloomfield	4,455	Hunting & Son.
Terek	3,710	Lane & Macandrew.
Kokine	1,427	Burmah Oil Co.
Syriam	1,427	Do.
Strombus	8,500	Shell Line Co.
Balakhani	3,696	Lane & Macandrew.
Total	31,447	

It appears that nearly all of these were constructed for the trade of foreign petroleum-producing countries, especially Java and Sumatra. English investors are of the opinion that the Eastern petroleum trade has a very promising future.

According to the London Petroleum Review—

The total number of tank steamers which have been constructed up to the present time for the general trade amounts to 159 steamships, having a total tonnage of 393,717, and 10 sailing vessels, of 11,321 tons, making the total vessels engaged in the general petroleum trade 169, representing a tonnage of 405,038.

The above figures, of course, do not include the whole of the vessels engaged in the petroleum trade, as there are a large number employed in the local trade of America and Russia which are constructed in the yards of the respective countries. Some idea, however, may be gained of the extent to which foreign countries contribute to the Caspian Sea tank-steamer fleet from the following figures:

Number and capacity of tank steamers engaged in Caspian Sea petroleum trade.

Country.	Number.	Capacity in cubic feet.
Russia	45	1,889,799
Sweden	49	1,553,884
United Kingdom	20	756,634
Germany	14	514,714

FOREIGN MARKETS.

In the following table is given a statement showing the foreign markets for our oil in the past eight years. As will be seen from this table, the total exports of illuminating oils decreased in 1899.

Exports of petroleum in its various forms from the United States from 1892 to 1899, by countries.

Country and kind.	1892.	1893.	1894.	1895.
CRUDE.				
Europe:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
France	69, 100, 657	69, 424, 609	84, 434, 953	72, 802, 459
Germany	5, 247, 209	4, 182, 963	4, 877, 593	3, 966, 870
Spain	17, 064, 929	21, 112, 042	15, 176, 034	15, 188, 547
United Kingdom	....	....	....	3, 997, 013
Other Europe	1, 935, 014	3, 948, 842	2, 009, 727	2, 590, 441
Total	93, 347, 809	98, 668, 456	106, 498, 307	98, 545, 330
North America:				
Mexico	3, 499, 514	5, 508, 769	8, 026, 189	5, 229, 983
Cuba	6, 316, 406	6, 955, 315	6, 865, 549	6, 980, 372
Other North America	425, 348	548, 068	534, 304	523, 579
Total	10, 241, 268	13, 012, 152	15, 426, 042	12, 733, 934
All other countries	3, 690	22, 900	2, 000	6, 000
Total crude	103, 592, 767	111, 703, 508	121, 926, 349	111, 285, 264
REFINED.				
Naphthas.				
Europe:				
France	1, 561, 284	4, 080, 839	3, 764, 569	1, 564, 360
Germany	3, 471, 652	4, 127, 354	4, 278, 757	4, 900, 028
United Kingdom	6, 813, 416	8, 209, 526	6, 834, 760	7, 343, 355
Other Europe	686, 398	658, 270	364, 135	577, 378
Total	12, 532, 750	17, 076, 989	15, 242, 221	14, 385, 121
North America	35, 762	122, 237	106, 454	145, 970
West Indies	....	....	67, 195	84, 299
South America	89, 609	55, 940	79, 777	135, 752
Asia and Oceania	57, 787	39, 625	57, 057	45, 217
Africa	12, 070	9, 214	3, 050	4, 865
Total	195, 228	227, 016	313, 533	416, 103
Total naphthas	12, 727, 978	17, 304, 005	15, 555, 754	14, 801, 224

Exports of petroleum in its various forms from the United States from 1892 to 1899, by countries—Continued.

Country and kind.	1892.	1893.	1894.	1895.
REFINED—continued.				
Illuminating.				
Europe:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
Belgium	31, 471, 121	33, 541, 439	36, 312, 974	35, 385, 765
Denmark	7, 019, 575	12, 262, 308	9, 290, 251	14, 626, 436
France	3, 005, 535	8, 161, 023	11, 812, 001	6, 204, 663
Germany	133, 417, 314	119, 277, 484	86, 388, 785	100, 829, 413
Italy	22, 324, 113	22, 815, 279	22, 945, 037	28, 017, 572
Netherlands	76, 607, 780	51, 298, 480	31, 868, 189	45, 900, 640
Sweden and Norway	11, 159, 824	16, 312, 922	9, 848, 074	24, 623, 246
United Kingdom	94, 901, 777	180, 996, 321	274, 555, 010	279, 064, 424
Other Europe	6, 450, 040	8, 654, 660	7, 232, 024	6, 586, 826
Total	386, 357, 079	453, 319, 916	490, 252, 345	541, 238, 985
North America:				
British North America	5, 735, 411	6, 341, 042	8, 218, 417	7, 621, 352
West Indies	4, 262, 935	4, 439, 118	4, 174, 856	4, 109, 358
Other North America	2, 250, 162	2, 204, 602	1, 759, 565	1, 501, 157
Total	12, 248, 508	12, 984, 762	14, 182, 838	13, 231, 867
South America:				
Argentina	4, 825, 196	4, 070, 719	3, 162, 846	5, 876, 742
Brazil	14, 028, 476	15, 556, 685	12, 154, 709	15, 315, 196
Uruguay	4, 293, 400	2, 882, 105	2, 520, 571	3, 898, 514
Other South America	6, 827, 814	6, 041, 571	5, 503, 680	7, 245, 123
Total	29, 974, 886	28, 551, 080	23, 341, 806	32, 335, 575
Asia and Oceania:				
China	17, 370, 600	27, 874, 230	40, 377, 296	18, 022, 800
Hongkong	16, 529, 790	12, 758, 820	16, 888, 820	10, 595, 610
East Indies	55, 907, 410	57, 404, 175	85, 907, 557	46, 680, 054
Japan	23, 761, 930	26, 869, 510	37, 272, 450	24, 298, 170
British Australasia	10, 376, 260	11, 053, 991	11, 821, 881	14, 686, 752
Other Asia and Oceania	3, 095, 516	2, 637, 250	2, 944, 958	3, 636, 230
Total	127, 041, 536	138, 597, 976	195, 212, 962	117, 919, 616
Africa	8, 865, 999	8, 206, 932	7, 049, 455	9, 676, 741
All other countries	408, 650	579, 150	329, 220	456, 360
Total illuminating	564, 896, 658	642, 239, 816	730, 368, 626	714, 859, 144

Exports of petroleum in its various forms from the United States from 1892 to 1899, by countries—Continued.

Country and kind.	1892.	1893.	1894.	1895.
REFINED—continued.				
Lubricating.				
Europe:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
Belgium	2, 632, 954	2, 426, 926	2, 931, 204	2, 679, 832
France	2, 461, 722	2, 426, 659	3, 050, 547	3, 271, 804
Germany	4, 512, 639	3, 798, 953	5, 637, 471	5, 378, 398
Italy	404, 971	788, 805	1, 356, 340	1, 381, 587
Netherlands	2, 229, 116	1, 842, 608	2, 346, 896	2, 641, 209
United Kingdom	18, 779, 806	17, 683, 132	19, 668, 767	21, 209, 497
Other Europe	209, 713	249, 474	415, 385	520, 025
Total	31, 240, 921	29, 216, 557	35, 406, 610	37, 082, 352
North America	656, 991	1, 043, 770	1, 308, 586	1, 248, 751
West Indies	....	....	417, 123	316, 274
South America	798, 194	1, 207, 232	1, 509, 708	2, 159, 844
Asia and Oceania	813, 618	888, 032	1, 433, 191	2, 438, 975
Africa	81, 352	77, 266	115, 359	172, 746
Total	2, 350, 155	3, 216, 300	4, 783, 967	6, 336, 590
Total lubricating	33, 591, 076	32, 432, 857	40, 190, 577	43, 418, 942
Residuum (barrels).				
Europe	6, 361	10, 404	2, 056	2, 099
North America	6, 622	2, 202	2, 460	1, 045
All other countries	287	276	513	130
Total residuum	13, 270	12, 882	5, 029	3, 274

Country and kind.	1896.	1897.	1898.	1899.
CRUDE.				
Europe:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
France	79, 242, 152	100, 153, 929	85, 125, 657	83, 630, 510
Germany	817, 212	2, 430, 249	3, 585, 777	3, 485, 360
Netherlands	4, 455, 469	2, 400, 000	2, 400, 000	2, 409, 040
Spain	12, 869, 235	12, 049, 778	9, 914, 851	9, 723, 420
United Kingdom	....	....	5, 060	310
Other Europe	1, 212, 528	1, 345, 360	136, 314	2, 391, 864
Total	98, 596, 596	118, 379, 316	101, 167, 659	101, 640, 504
North America:				
Mexico	6, 779, 059	7, 090, 850	7, 713, 859	7, 969, 871
Cuba	4, 838, 657	4, 772, 589	3, 829, 463	3. 297. 175
Porto Rico	....	....	....	160, 000
Other North America	708, 008	623, 958	585, 390	20, 510
Total	12, 325, 724	12, 487, 397	12, 128, 712	11, 447, 556

Exports of petroleum in its various forms from the United States from 1892 to 1899, by countries—Continued.

Country and kind.	1896.	1897.	1898.	1899.
CRUDE—continued.				
South America:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
Brazil		841, 140		
Other South America			1, 026	
Total		841, 140	1, 026	
All other countries	1, 300	18, 390		
Total crude	110, 923, 620	131, 726, 243	113, 297, 397	113, 088, 060
REFINED.				
Naphthas.				
Europe:				
France	1, 672, 056	2, 103, 725	1, 713, 646	1, 517, 758
Germany	2, 814, 217	2, 800, 883	6, 135, 309	4, 716, 306
Netherlands		1, 400, 000	1, 500	1, 477, 034
United Kingdom	7, 236, 285	7, 125, 371	7, 380, 140	7, 584, 526
Other Europe	160, 658	281, 541	382, 201	414, 597
Total	11, 883, 216	13, 711, 520	15, 612, 796	15, 710, 221
North America	208, 249	256, 869	290, 372	251, 879
West Indies	104, 062	83, 529	18, 261	15, 864
South America	96, 020	67, 178	85, 492	137, 743
Asia and Oceania	49, 927	120, 479	231, 487	120, 123
Africa	7, 845	9, 453	14, 521	16, 955
Total	466, 103	537, 508	640, 133	542, 564
Total naphthas	12, 349, 319	14, 249, 028	16, 252, 929	16, 252, 785
Illuminating.				
Europe:				
Belgium	35, 413, 132	42, 437, 133	44, 317, 797	40, 715, 711
Denmark	12, 693, 927	14, 001, 755	18, 969, 052	17, 548, 051
France	5, 338, 501	2, 736, 190	5, 875, 777	3, 994, 908
Germany	121, 841, 266	114, 583, 356	137, 981, 137	115, 124, 570
Italy	22, 648, 184	24, 525, 066	18, 705, 089	19, 750, 201
Netherlands	122, 510, 644	126, 341, 441	134, 204, 836	138, 188, 341
Sweden and Norway	10, 582, 677	18, 961, 261	23, 567, 695	17, 345, 423
United Kingdom	181, 883, 052	185, 200, 507	179, 160, 587	178, 796, 530
Portugal	4, 286, 732	4, 712, 019	5, 500, 240	2, 692, 476
Other Europe	3, 862, 377	2, 488, 975	3, 821, 197	2, 787, 050
Total	521, 060, 492	535, 987, 703	572, 103, 407	536, 943, 261

Exports of petroleum in its various forms from the United States from 1892 to 1899, by countries—Continued.

Country and kind.	1896.	1897.	1898.	1899.
REFINED—continued.				
Illuminating—Continued.				
North America:				
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
British North America	9, 141, 934	9, 071, 814	9, 952, 286	9, 861, 600
Central America	1, 371, 502	1, 201, 053	1, 034, 878	1, 075, 322
Mexico	241, 061	335, 692	550, 544	581, 222
West Indies—British	2, 712, 126	2, 661, 734	2, 675, 186	2, 609, 283
West Indies—Other	2, 189, 271	2, 218, 373	2, 234, 338	2, 899, 504
Other North America	60, 864	63, 548	42, 020	40, 045
Total	15, 716, 758	15, 552, 214	16, 489, 252	17, 066, 976
South America:				
Argentina	7, 803, 218	9, 703, 792	10, 648, 733	6, 483, 293
Brazil	18, 490, 043	19, 819, 941	19, 569, 447	16, 289, 130
Chile	4, 325, 915	3, 622, 300	3, 923, 448	3, 685, 800
Uruguay	3, 622, 810	2, 821, 420	3, 576, 570	1, 760, 465
Venezuela	1, 483, 127	1, 456, 472	1, 417, 804	1, 327, 681
Other South America	2, 784, 155	3, 049, 493	2, 820, 834	2, 760, 223
Total	38, 509, 268	40, 473, 418	41, 956, 836	32, 306, 592
Asia:				
China	25, 694, 890	42, 516, 120	44, 324, 344	22, 683, 425
Hongkong	10, 499, 000	14, 977, 050	15, 637, 420	18, 095, 260
East Indies—British	24, 762, 150	19, 276, 390	33, 341, 284	20, 109, 900
East Indies—Dutch	16, 947, 830	24, 898, 000	12, 534, 930	15, 371, 400
Japan	33, 701, 038	46, 252, 501	51, 621, 050	32, 705, 180
Other Asia	3, 782, 300	5, 085, 030	4, 119, 840	155, 700
Total	115, 387, 208	153, 005, 091	161, 578, 868	109, 120, 865
Oceania:				
British Australasia	13, 721, 827	15, 329, 222	18, 859, 348	14, 396, 782
Hawaiian Islands	629, 740	391, 150	785, 740	1, 049, 210
Other Oceania	1, 149, 665	623, 490	1, 089, 215	23, 575
Total	15, 501, 232	16, 343, 862	20, 734, 303	15, 469, 567
British Africa	5, 064, 858	4, 851, 040	5, 963, 379	7, 540, 818
Other Africa	5, 215, 749	5, 137, 298	5, 600, 536	3, 831, 401
Total illuminating	716, 455, 565	771, 350, 626	824, 426, 581	722, 279, 480

Exports of petroleum in its various forms from the United States from 1892 to 1899, by countries—Continued.

Country and kind.	1896.	1897.	1898.	1899.
REFINED—continued.				
Lubricating.				
Europe:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
Belgium	4,078,951	3,784,941	3,872,617	4,625,800
France	5,165,586	4,225,199	5,246,208	6,500,107
Germany	5,990,561	6,877,196	8,086,776	8,233,910
Italy	1,324,994	1,550,688	1,970,890	1,921,123
Netherlands	2,724,546	2,840,832	4,196,352	4,332,727
United Kingdom	23,436,081	21,301,290	25,724,836	26,353,051
Other Europe	815,017	1,011,201	920,919	1,755,551
Total	43,535,736	41,591,347	50,018,598	53,722,269
North America	1,244,538	1,259,249	1,429,468	1,549,299
West Indies	213,304	114,942	186,285	416,688
South America	2,221,780	1,876,794	1,971,050	2,899,295
Asia and Oceania	3,000,471	4,879,886	5,978,725	7,737,421
Africa	309,701	477,127	715,239	1,099,421
Total	6,989,794	8,607,998	10,280,767	13,702,124
Total lubricating	50,525,530	50,199,345	60,299,365	67,424,393
Residuum (barrels).				
Europe	4,248	140,777	471,604	724,241
North America	438	566	1,680	5,299
All other countries	194	1,269	2,278	674
Total residuum	4,880	142,612	475,562	730,214

AVERAGE PRICE FOR REFINED OIL.

In the following table the average price per gallon of 70° Abel test refined oil, in barrels at New York, for each month of the past eight years is given:

Average monthly prices of 70° Abel test refined oil at New York since 1892.

Month.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	6.45	5.33	5.15	5.87	7.85	6.13	5.40	7.43
February	6.42	5.30	5.15	6.00	7.35	6.26	5.48	7.40
March	6.32	5.34	5.15	6.75	7.40	6.36	5.82	7.33
April	6.10	5.52	5.15	9.12	7.00	6.13	5.67	7.05
May	6.06	5.20	5.15	8.20	6.75	6.23	6.00	7.01
June	6.00	5.21	5.15	7.83	6.85	6.14	6.16	7.20
July	6.00	5.15	5.15	7.65	6.55	5.87	6.27	7.61
August	6.08	5.18	5.15	7.10	6.65	5.75	6.44	7.82
September	6.10	5.15	5.15	7.10	6.85	5.74	6.60	8.63
October	6.03	5.15	5.15	7.10	6.90	5.55	7.21	9.00
November	5.80	5.15	5.15	7.88	7.15	5.40	7.35	9.40
December	5.45	5.15	5.61	7.77	6.35	5.40	7.40	9.85
Yearly average	6.07	5.24	5.19	7.36	6.98	5.91	6.32	7.98

NOTE.—Refined oil is loaded on bulk steamers at 2.5 cents per gallon below the above quotations.

Wholesale prices of refined petroleum at New York, at the first of each month, 1895 to 1899, inclusive.

Month.	1895.			1896.			1897.			1898.			1899.		
		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.
	Dates.	Per gall.	Per gall.	Dates.	Per gall.	Per gall.	Dates.	Per gall.	Per gall.	Dates.	Per gall.	Per gall.	Dates.	Per gall.	Per gall.
		Cents.	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*
January	2	5.70	6.90	1	7.75	8.50	6	6.20	6.90	1	5.40	5.95	7	7.50	8.25
February	6	5.80	7.13	5	7.60	8.50	3	6.00	6.70	2	5.40	5.95	4	7.40	8.15
March	6	6.30	7.40	4	7.10	8.00	3	6.30	7.00	2	6.20	6.85	4	7.35	8.10
April	3	7.35	7.70	1	7.20	8.10	7	6.20	6.66	6	5.70	6.35	3	7.25	8.00
May	1	8.50	9.65	6	6.95	7.85	5	6.05	6.50	4	5.60	6.25	6	6.95	7.70
June	5	7.85	8.50	3	6.55	7.45	2	6.15	6.60	1	6.15	6.80	3	7.20	7.95
July	3	7.80	8.15	1	6.90	7.30	7	6.00	6.45	6	6.15	6.80	1	7.35	8.10
August	7	7.10	7.50	5	6.65	7.55	4	5.75	6.20	3	6.40	7.05	5	7.80	8.80
September	4	7.10	7.50	2	6.70	7.60	1	5.75	6.15	7	6.50	7.15	2	8.25	9.50
October	2	7.10	7.50	7	6.90	7.85	6	5.80	6.15	5	6.85	7.50	7	8.95	10.20
November	6	7.10	7.50	4	7.00	7.95	3	5.40	5.95	2	7.40	8.15	4	9.25	10.50
December	4	7.50	8.50	2	6.70	7.55	1	5.40	5.95	7	7.40	8.15	2	9.65	10.75

Monthly average prices per gallon of oil exported from the United States in bulk in 1899.

Month.	Mineral, crude.	Refined, illuminating.
	Cents.	*Cents.*
January	4.8	4.9
February	4.7	4.9
March	4.7	4.8
April	5.1	4.5
May	4.8	4.5
June	4.6	4.7
July	4.8	5.1
August	4.9	5.3
September	5.1	6.1
October	5.4	6.5
November	5.5	6.9
December	5.9	7.3

Prices of American refined petroleum at Antwerp, Bremen, and London in 1899.

1899.	Antwerp (francs per 100 kilograms).	Bremen (marks per 50 kilograms).	London (pence per gallon).
January 1 to 15	$19\frac{5}{8}$	7.05	$6\frac{1}{4}$–$6\frac{1}{2}$
January 15 to 31	$19\frac{5}{8}$	7.05	$6\frac{3}{8}$–$6\frac{1}{2}$
February 1 to 14	$19\frac{5}{8}$	7.05	$6\frac{3}{8}$–6
February 14 to 28	$19\frac{5}{8}$	7.05–6.90	$5\frac{7}{8}$
March 1 to 15	$19\frac{5}{8}$	6.90	$5\frac{7}{8}$
March 15 to 31	$19\frac{5}{8}$–$16\frac{1}{2}$	6.90–6.70	$5\frac{7}{8}$–$5\frac{5}{8}$
April 1 to 15	$16\frac{1}{2}$–$17\frac{1}{4}$	6.70–6.40	$5\frac{5}{8}$–$5\frac{1}{8}$
April 15 to 30	$17\frac{1}{4}$–18	6.40–6.25	$5\frac{1}{8}$–5
May 1 to 15	18	6.25–6.20	$5\frac{1}{4}$–$5\frac{3}{8}$
May 15 to 31	$17\frac{1}{2}$	6.10–6.20	$5\frac{3}{8}$
June 1 to 15	$17\frac{1}{2}$	6.20	$5\frac{1}{4}$–$5\frac{3}{8}$
June 15 to 30	$17\frac{1}{2}$	6.20	$5\frac{3}{8}$–$5\frac{5}{8}$
July 1 to 15	$17\frac{1}{2}$–$18\frac{1}{4}$	6.20–6.70	$5\frac{1}{2}$–6
July 15 to 31	$18\frac{1}{4}$	6.70–6.95	6 –$6\frac{1}{8}$
August 1 to 15	$18\frac{1}{4}$	6.95	$6\frac{1}{8}$
August 15 to 31	$18\frac{1}{4}$	6.95	$6\frac{1}{8}$
September 1 to 15	$19\frac{1}{4}$–$20\frac{1}{2}$	7.30–7.70	$6\frac{1}{4}$–$6\frac{3}{4}$
September 15 to 30	$20\frac{1}{4}$–$21\frac{1}{4}$	7.70–7.90	$6\frac{3}{4}$–7
October 1 to 15	$21\frac{1}{4}$	7.95	$6\frac{7}{8}$–7
October 15 to 31	$21\frac{1}{4}$–$21\frac{3}{4}$	7.95–8.05	$6\frac{7}{8}$–7
November 1 to 15	$21\frac{3}{4}$–22	8.15	7 –$7\frac{1}{8}$
November 15 to 30	22 –$22\frac{3}{4}$	8.15–8.30	$7\frac{1}{8}$–$7\frac{3}{8}$
December 1 to 15	$22\frac{3}{4}$–$23\frac{1}{4}$	8.30–8.45	$7\frac{1}{4}$–$7\frac{1}{2}$
December 15 to 31	$23\frac{1}{4}$	8.45	$7\frac{1}{2}$–$7\frac{3}{8}$

PRODUCTION BY FIELDS, STATES, AND DISTRICTS.

The detailed results of the petroleum operations in the Appalachian oil field in 1899, by States, fields, and districts, and in the Lima-Indiana field, are presented in the pages that follow. A portion of both these fields is embraced within the geographical limits of Ohio, and the discussion of production, wells, etc., for both fields will be found under the head of Ohio.

APPALACHIAN OIL FIELD.

From the beginning of 1899 until the close, the greatest activity prevailed in all parts of the Appalachian oil field. An advancing market provided the stimulus that kept the drill busy wherever there was any available territory in the old fields, and in the effort to discover new producing districts it was used for prospecting in localities far removed from the paths established by former explorations. Old wells were carefully nursed and the smallest producers operated with a fair profit, by the adoption of more economical appliances for raising the oil to the surface. Hundreds of wells that had been partially abandoned during the era of low prices prevailing in the early part of 1898 were revived and added their mite in helping to swell the increasing production. The market, which ranged from $1.13 to $1.19 per barrel during the first five months of 1899, made steady advances from July on, and the year closed with $1.66 as the ruling price for Pennsylvania petroleum.

There was a continued effort to enlarge the areas of the older sections of the Appalachian field during the year, and both West Virginia and southeastern Ohio furnished several new pools which proved very productive. The northeastern portion of the field presented few noteworthy features, although every district was well represented in the field reports at the close of each month. Since January 1877, there is a record of 95,848 completed wells in the Appalachian oil field, of which number 16,734 failed to find oil in paying quantities. At an average cost of $2,000 each, these wells represent an aggregate capital of $191,696,000. The total number of wells completed in the eastern oil field since the beginning of developments on Oil Creek in 1859 must approximate close to 109,000. During the ten years closing with December, 1899, 52,242 wells were completed in the oil districts and 10,000 or more in the gas districts of the Appalachian field. About 25 per cent of all the wells drilled proved barren of oil in paying quantities.

Under the heads of the several States more complete details are given in regard to the different divisions that are included under the general title of the Appalachian field.

NEW YORK.

The Allegany field, which forms the most northeastern portion of the great belt of territory producing what is known as Pennsylvania oil, is the only district entirely within the borders of New York State. It is located in Allegany County, and extends through most of the townships in the lower part of the county. The Bradford oil region lies partly in Cattaraugus County, New York, but by far the greater portion of its area is in McKean County, Pennsylvania.

The total production of the Allegany field in 1899 was 807,814 barrels, as compared with 757,492 barrels in 1898 and 771,606 barrels in 1897. The increase the past year was 50,322 barrels, or about 6½ per cent, over the year preceding. This territory was at its maximum in 1882, when from about 2,000 wells there was an average daily yield of over 8 barrels to the well for the entire year.

The present daily production is about 2,000 barrels. There were 597 wells drilled in the Allegany field in 1899, as compared with 264 in 1898 and 350 in 1897. The total production of the Allegany field for the past twenty years was over 33,000,000 barrels. For 1899 the production of New York State, including the northern portion of the Bradford oil district, was placed at 1,320,909 barrels, which, at \$1.29⅜ per barrel, was valued at \$1,708,926. For 1898 the production was 1,205,250 barrels, and the value \$1,098,284. The New York production of the Bradford field for 1899 was estimated at 519,095 barrels. The combined production of New York and Pennsylvania in the Bradford district will be found in the tables under the head of Pennsylvania.

PENNSYLVANIA.

Bradford district.—The area of new territory, known as the Chipmunk region, added to the northern borders of the great Bradford oil district along the Allegheny River was pretty thoroughly drilled over in 1899. There was a general revival of operations in all sections of the field, and the odd nooks and corners left over from previous years were most thoroughly explored. Small extensions were made to the field in the west and southwest, but they were not of sufficient importance to check the waning production of the vast number of old wells, and although more wells were drilled in 1899 than in 1898, the total yield of the field showed a decline of 237,364 barrels, or about 7 per cent.

There were 642 wells completed in the Bradford field in 1899, 488 in 1898, and 696 in 1897. The dry holes numbered 100 in 1899, 63 in 1898, and 114 in 1897. The production of the district for the year was 3,206,845 barrels, as compared with 3,444,299 barrels in 1898 and 3,904,230 barrels in 1897.

The new development near Gaines in the western part of Tioga

County, nearly 50 miles east of Bradford, furnished some fair wells during the year, but the new production from this source was small. The oil is found above the Bradford formation, in two distinct strata, which have become known locally as the "Atwell" and "Sweeney" sands. As yet nothing has been discovered to indicate that the area of this development will prove at all extensive.

Warren and Forest counties district.—This section, which is likewise known as the middle field, includes the southern and western portions of McKean County, nearly all of Warren, the northwestern portion of Elk, and the north and northeastern parts of Forest County. The district is further divided into three parts—the Tiona, the Warren and Clarendon, and the Middle sections. The oil produced in a part of this district is of a superior quality and generally commands a premium of 15 cents a barrel over the ordinary grade of Pennsylvania petroleum. The production of the Warren and Forest counties district amounted to 1,155,009 barrels in 1899, 1,597,659 barrels in 1898, and 1,999,108 barrels in 1897. The decrease the past year was 442,650 barrels, while the decrease for 1898 was 401,449 barrels. There was an increase in operations in this section during 1899, but the new wells were neither large nor numerous enough to check the waning production. In 1899 558 wells were completed, including 103 dry holes, as compared with 388 wells in 1898, 94 of which were dry. The production in this district declined 27 per cent in 1899, while the number of wells drilled increased about 44 per cent.

Lower district.—This is the oldest and most extensive district in the Appalachian field. Beginning with the southern portion of Forest County on the north, it embraces all the oil developments of Crawford, Venango, Clarion, Butler, and Armstrong counties, extending clear through to the Allegheny County line. A number of new pools were opened up in this district during 1899, and the greatest activity prevailed throughout every portion. The advancing market caused a general cleaning out of old wells, and a great deal of drilling was done in old territory that had been steadily drained for the past thirty years. A greater number of small wells were drilled during 1899 than in any other year in the history of the oil industry. Many of these wells in former years would have been pulled out and abandoned as losing ventures, but the higher prices paid for crude oil enabled even the very smallest of them to be operated at a fair margin of profit. The production of this district, in spite of the activity everywhere displayed in the field, declined from 5,500,443 barrels in 1898 to 5,080,182 barrels in 1899. This is a decrease of 420,261 barrels, or 7.6 per cent. The production for 1897 was 6,825,599 barrels. The wells completed in this district numbered 2,234 in 1899 and 1,271 in 1898. There were 437 dry holes drilled in 1899 and 342 in 1898. With no new sources of supply to draw upon, the production of this district must continue to steadily decline.

Washington County district.—Not a single new pool nor an extension to any old one was brought to light in this once great section of the producing region during the year 1899. The total production is placed at 1,460,036 barrels for 1899, as against 1,742,677 barrels in 1898 and 2,175,712 barrels in 1897. Drilling operations were confined entirely to old locations, passed by in the earlier days of this district. The decline in production was 16 per cent in 1899 and 20 per cent in 1898.

Allegheny County district.—A third sand strike near Gibsonia proved the incentive for considerable activity in Allegheny County the past year, but it turned out very narrow, and the few good producers discovered were more than offset by a multiplicity of small wells and dry holes. The old Brush Creek pool furnished some staying wells, and a few small wells were drilled along the edges of the great McDonald field that created such an excitement in 1891–92. The Milltown pool likewise occupied a little prominence during the year, by reason of a good strike on the Hunter farm, but it rapidly declined, and operators were compelled to abandon the field in disgust. The Allegheny County district produced 1,988,754 barrels of oil in 1899, a decrease of 312,897 barrels from the record of 1898. This is a decline of over 13 per cent. The production of 1898 was 2,301,651 barrels, and for 1897, 2,958,540 barrels. There has been a steady decline for several years past. A decrease of 22 per cent was recorded in 1898 and of 48 per cent in 1897.

Beaver County district.—This district made a gain in production during 1899, the figures showing an increase of 11,358 barrels, or a little over 5 per cent. The total production for 1899 was 232,154 barrels, as compared with 220,796 barrels in 1898 and 317,926 barrels in 1897. There was a little excitement near Legionville toward the close of the year, when a 200-barrel strike was made on the Frederick Moore farm. It caused the starting of some new work, but of the eight wells drilled in the same vicinity four turned out to be dry holes.

Greene County district.—Greene County has so far been very deceptive. While a number of large wells have been found in this county, some of which were classed with the gushers, they have been generally offset by dry holes in close proximity, and as the wells in this section are from 2,700 to 3,000 feet in depth a dry hole represents a large amount of loss. The Fonner pool, which started off at the rate of 1,700 barrels per day in March, 1897, was producing at the rate of 200 barrels per day in 1898, and became an insignificant factor in 1899. Several fair wells were found in this pool in the early part of 1899, but the dry holes far outnumbered the producers. Toward the close of 1899 the production from this field had dwindled to an insignificant amount. The Bristoria pool, in southwestern Greene County, furnished a number of large producers, accompanied

by a larger number of dry holes, in what is considered the equivalent of the Gordon sand.

One of the most remarkable wells in the entire history of the output of individual wells is located in this pool on the Emma Wood farm, on Long Run, Aleppo Township, and has the following history: On March 17, 1898, the pay sand was pierced by the drill. The flow commenced at the rate of 1,000 barrels per day; at the end of that year it was producing over 330 barrels per day, and at the end of 1899 over 250 barrels per day, having placed a total of 110,000 barrels to its credit in twenty-one and a half months, showing an average of 302 barrels per day. This was done "natural," as it was not torpedoed nor pumped at any time. There were a number of light wells from the deep sand drilled in the field northwest of New Freeport, in Greene County, but quite a number of dry holes were also found scattered among the producers.

Toward the latter part of July, in 1899, an important well was drilled into the pay streak on the William Lantz farm, 2½ miles west of Blacksville, West Virginia, and about one-fourth of a mile north of the State line. From the first pay of the fifth sand it produced 50 barrels the first day. Deeper drilling developed two other pay streaks, which put up its production to 250 barrels per day. Two or three additional wells drilled in this new field before the close of the year were good producers and seem to warrant the belief that this section will produce a large amount of petroleum in 1900. Indications seem to point to the fact that this pool is an extension of the Campbells Run pool, coming northeast through Marion and Monongalia counties, West Virginia. Some powerful gas wells have been found in this section farther northeast in the fifth and the Bayard sand, 110 feet below.

Some fine wells have been drilled in the old Mount Morris pool, in the Big Injun sand. One or two producers have been found in the old Graysville and Nineveh pools, but the dry holes have outnumbered the productive wells in both sections.

Greene County also showed an increase in production during 1899. The district produced 381,433 barrels of petroleum in 1899, as compared with 325,177 barrels in 1898. This was a gain of a little over 17 per cent. The gain for the preceding year was 26 per cent. This district and that of Beaver were the only ones in Pennsylvania that showed any increase in 1899.

This district during 1899 produced some good gas wells to the southeast of Waynesburg, 8 or 9 miles from the "Bayard sand," which are more fully discussed in the natural-gas report.

Franklin district.—The vicinity of Franklin, Venango County, has long been famed for the production of a remarkably fine grade of heavy petroleum, which is used for lubricating purposes in all parts of the United States and in several foreign countries. This oil is

found in a heavy bed of sandstone, at comparatively shallow depths. The wells are very small and always contain salt water in large quantities. The production of this grade of oil amounted to 61,085 barrels in 1899, 64,470 barrels in 1898, and 57,466 barrels in 1897. The price paid for this product is $4 a barrel, and has been the ruling quotation for over seven years. The entire field is embraced within an area 4 miles long and of about the same width. The wells are drilled very close to one another and are pumped in clusters of fifty to one hundred by being connected and operated by a common power. The oil is of heavy gravity and seems to be found nowhere else in the county.

There are two fields, separated by a few miles, producing lubricating petroleum, at Volcano and Petroleum in West Virginia. The output of these fields in 1899 was 17,724 barrels, valued at $2.30 per barrel, as compared with 11,965 barrels, valued at $2.55, in 1898.

The quantity of lubricating petroleum produced in the Mecca and Belden pools in Ohio in 1899 was only 799 barrels, valued at $5.31 per barrel—the quality of this natural oil for lubricating purposes as it comes out of the rock is unsurpassed.

PENNSYLVANIA AND NEW YORK OIL FIELD.

PRODUCTION.

As the Bradford field extends to a considerable distance within the border of New York State, and since there has been no effort made to keep its output apart from that of Pennsylvania, it is a rather difficult matter to obtain an accurate statement of the production, shipments, and stocks of the two States separately. It is possible to do so, in some degree, in the case of West Virginia and southeastern Ohio, but where the oil districts lap over along the dividing line of two States, the statistics of completed wells, production, etc., are generally combined. It would prove of great interest if these figures could be given separately and accurately for each of the four States in the Appalachian field, but nothing more than approximate estimates can be claimed.

In the following table will be found a statement of the production of crude petroleum in Pennsylvania and New York for the year 1899, by districts and months:

Production of crude petroleum in Pennsylvania and New York in 1899, by districts and months.

[Barrels of 42 gallons.]

District.	January.	February.	March.	April.	May.
Allegany County, New York	59,475	53,200	64,604	70,454	69,068
Bradford	263,655	245,610	285,722	277,062	280,380
Clarendon and Warren	38,441	31,764	36,900	34,740	34,708
Middle	44,272	40,110	48,637	44,975	44,181
Tiona	17,368	15,461	19,902	19,248	18,011
Lower	400,467	364,005	437,243	423,613	437,308
Washington County	110,041	100,670	124,170	115,588	132,310
Allegheny County	167,060	146,650	179,027	165,259	167,775
Beaver County	18,819	15,540	20,409	17,558	20,840
Greene County	33,338	25,473	30,466	30,057	30,354
Total	1,152,936	1,038,483	1,247,080	1,198,554	1,234,935
Franklin	3,311	4,870	6,514	4,915	6,971
Smiths Ferry	100	95	105	100	90
Grand total	1,156,347	1,043,448	1,253,699	1,203,569	1,241,996

District.	June.	July.	August.	September.
Allegany County, New York	72,547	70,180	73,720	67,860
Bradford	272,731	266,406	269,792	261,779
Clarendon and Warren	34,068	35,273	34,053	33,150
Middle	44,812	43,899	45,827	42,957
Tiona	17,473	18,957	18,203	16,314
Lower	429,815	424,740	448,042	435,827
Washington County	130,354	119,016	131,701	124,309
Allegheny County	160,162	165,647	161,956	177,098
Beaver County	19,398	18,592	18,595	18,147
Greene County	30,143	33,604	37,055	30,567
Total	1,211,503	1,196,314	1,238,944	1,208,008
Franklin	5,323	5,260	4,645	5,270
Smiths Ferry	90	95	100	90
Grand total	1,216,916	1,201,669	1,243,689	1,213,368

Production of crude petroleum in Pennsylvania and New York in 1899, by districts and months—Continued.

[Barrels of 42 gallons.]

District.	October.	November.	December.	Total.
Allegany County, New York	70, 068	72, 369	64, 269	807, 814
Bradford	267, 222	265, 437	251, 049	3, 206, 845
Clarendon and Warren	34, 938	32, 705	33, 612	414, 352
Middle	44, 157	42, 302	42, 311	528, 440
Tiona	18, 150	16, 630	16, 500	212, 217
Lower	437, 477	427, 171	414, 474	5, 080, 182
Washington County	124, 112	123, 988	123, 777	1, 460, 036
Allegheny County	179, 370	163, 576	155, 174	1, 988, 754
Beaver County	18, 460	23, 398	22, 398	232, 154
Greene County	30, 713	31, 961	37, 752	381, 483
Total	1, 224, 667	1, 199, 537	1, 161, 316	14, 312, 277
Franklin	4, 612	5, 486	3, 908	61, 085
Smiths Ferry	95	100	90	*a* 1, 150
Grand total	1, 229, 374	1, 205, 123	1, 165, 314	14, 374, 512

a This production only represents dump oil, the pipe-line runs of this district being included in runs of Beaver County.

In the following table will be found a statement of the production of crude petroleum in Pennsylvania and New York in the years 1891 to 1899, by districts:

Production of crude petroleum in Pennsylvania and New York in the years 1891 to 1899, by districts.

[Barrels of 42 gallons.]

Year.	Allegany County, New York.	Bradford.	Bullion.	Clarendon and Warren.	Grand Valley.	Holiday Run.	Middle.
1891	1, 121, 574	5, 452, 418	117, 463	360, 227	198, 954	47, 551	1, 536, 606
1892	908, 603	4, 291, 061	....	272, 523	128, 101	....	1, 145, 320
1893	733, 709	3, 502, 136	....	327, 680	54, 700	....	1, 249, 067
1894	656, 845	3, 359, 835	....	338, 570	46, 000	....	1, 169, 628
1895	637, 139	3, 244, 808	....	369, 747	20, 988	....	1, 149, 404
1896	736, 606	3, 604, 771	....	385, 294	....	....	956, 390
1897	771, 606	3, 904, 230	....	378, 075	....	....	1, 329, 448
1898	757, 492	3, 444, 299	....	414, 212	....	....	932, 000
1899	807, 814	3, 206, 845	....	414, 352	....	....	528, 440

Production of crude petroleum in Pennsylvania and New York in the years 1891 to 1899, by districts—Continued.

[Barrels of 42 gallons.]

Year.	Second Sand.	Tarkill and Egypt.	Tiona.	Tidioute and Titusville.	Lower.	Washington County.
1891....	268,855	868,275	553,730	837,287	6,952,539	2,997,278
1892....	272,011	....	475,708	629,164	6,837,703	2,452,388
1893....	245,205	....	286,597	225,348	5,396,969	2,077,564
1894....	315,724	....	318,611	183,425	5,760,574	1,720,780
1895....	260,872	....	325,843	50,129	6,904,355	1,676,676
1896....	....	....	309,252	....	7,539,807	1,975,169
1897....	....	....	291,585	....	6,825,599	2,175,712
1898....	....	....	251,447	....	5,500,443	1,742,677
1899....	....	....	212,217	....	5,080,182	1,460,036

Year.	Allegheny County.	Beaver County.	Greene County.	Franklin.	Smiths Ferry.	Total.
1891....	10,317,258	943,223	341,813	65,185	29,000	33,009,236
1892....	10,196,856	623,372	102,108	58,459	29,000	28,422,377
1893....	5,488,792	465,300	74,377	66,278	20,793	20,314,513
1894....	4,559,342	466,790	64,176	57,070	2,620	19,019,990
1895....	3,864,111	472,276	116,931	48,711	2,400	19,144,390
1896....	4,380,007	550,296	94,796	49,329	2,704	20,584,421
1897....	2,958,540	317,926	258,065	48,880	2,400	19,262,066
1898....	2,301,651	220,796	325,177	56,090	2,180	15,948,464
1899....	1,988,754	232,154	381,483	61,085	1,150	14,374,512

All of the districts named in the above tables are wholly within the State of Pennsylvania, except Allegany and a portion of the Bradford district, referred to under the head of New York State.

Total product of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1899, by months and years.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1871....	418, 407	372, 568	400, 334	385, 980	408, 797
1872....	583, 575	462, 985	461, 590	462, 090	537, 106
1873....	632, 617	608, 300	665, 291	641, 520	776, 364
1874....	1, 167, 243	835, 492	883, 438	778, 740	895, 745
1875....	852, 159	719, 824	789, 539	675, 060	696, 508
1876....	712, 225	668, 885	718, 177	701, 490	735, 351
1877....	842, 890	783, 216	901, 697	972, 810	1, 127, 594
1878....	1, 203, 296	1, 094, 856	1, 208, 380	1, 195, 890	1, 264, 862
1879....	1, 369, 921	1, 261, 935	1, 499, 315	1, 530, 450	1, 644, 922
1880....	1, 904, 113	1, 870, 008	2, 015, 992	2, 015, 700	2, 228, 931
1881....	2, 244, 090	1, 913, 128	2, 274, 532	2, 205, 780	2, 393, 293
1882....	2, 353, 551	2, 131, 332	2, 482, 170	2, 402, 790	2, 486, 572
1883....	1, 948, 319	1, 756, 188	1, 830, 674	1, 816, 530	1, 962, 052
1884....	1, 825, 838	1, 880, 650	2, 052, 262	2, 065, 860	2, 381, 854
1885....	1, 652, 176	1, 437, 884	1, 638, 133	1, 780, 290	1, 771, 371
1886....	1, 748, 958	1, 604, 848	1, 928, 448	1, 938, 360	2, 178, 373
1887....	1, 990, 851	1, 827, 924	2, 007, 196	1, 960, 860	1, 993, 517
1888....	1, 155, 937	1, 290, 718	1, 338, 877	1, 349, 403	1, 473, 362
1889....	1, 542, 806	1, 332, 482	1, 628, 661	1, 635, 933	1, 821, 776
1890....	2, 108, 248	2, 055, 424	2, 313, 189	2, 328, 870	2, 378, 382
1891....	2, 830, 081	2, 287, 320	2, 360, 011	2, 337, 498	2, 288, 656
1892....	2, 786, 528	2, 703, 663	2, 657, 432	2, 574, 814	2, 485, 040
1893....	1, 723, 918	1, 671, 620	1, 900, 363	1, 682, 271	1, 763, 655
1894....	1, 579, 420	1, 432, 251	1, 662, 595	1, 537, 500	1, 628, 149
1895....	1, 570, 742	1, 318, 322	1, 585, 887	1, 656, 436	1, 630, 829
1896....	1, 648, 367	1, 517, 806	1, 632, 234	1, 842, 564	1, 746, 089
1897....	1, 591, 700	1, 556, 488	1, 730, 502	1, 611, 633	1, 619, 548
1898....	1, 429, 207	1, 263, 963	1, 465, 570	1, 359, 701	1, 371, 344
1899....	1, 156, 347	1, 043, 448	1, 253, 699	1, 203, 569	1, 241, 996

Total product of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1899, by months and years—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.
1871	410, 340	456, 475	462, 582	461, 940
1872	491, 130	517, 762	549, 909	500, 430
1873	793, 470	867, 473	936, 138	954, 270
1874	621, 750	1, 033, 447	931, 519	840, 630
1875	696, 210	788, 361	718, 766	698, 940
1876	723, 600	763, 623	782, 223	780, 600
1877	1, 130, 790	1, 189, 005	1, 273, 759	1, 214, 910
1878	1, 217, 250	1, 283, 865	1, 341, 928	1, 315, 710
1879	1, 675, 650	1, 637, 767	1, 892, 302	1, 856, 700
1880	2, 158, 440	2, 248, 430	2, 341, 027	2, 346, 300
1881	2, 377, 860	2, 372, 678	2, 331, 727	2, 193, 420
1882	2, 825, 940	3, 258, 162	3, 104, 495	2, 620, 380
1883	1, 977, 900	2, 020, 394	1, 879, 437	1, 913, 370
1884	1, 862, 190	2, 059, 950	2, 099, 165	1, 948, 260
1885	1, 767, 210	1, 775, 804	1, 705, 961	1, 712, 790
1886	2, 335, 380	2, 418, 961	2, 413, 206	2, 418, 540
1887	1, 912, 860	1, 899, 525	1, 848, 877	1, 779, 930
1888	1, 450, 703	1, 394, 847	1, 382, 077	1, 273, 080
1889	1, 811, 485	1, 954, 168	1, 964, 227	1, 867, 610
1890	2, 370, 001	2, 524, 206	2, 514, 968	2, 584, 949
1891	2, 316, 988	2, 289, 089	2, 473, 398	2, 837, 562
1892	2, 439, 346	2, 360, 886	2, 328, 596	2, 125, 511
1893	1, 780, 836	1, 720, 088	1, 691, 652	1, 614, 021
1894	1, 663, 964	1, 624, 767	1, 612, 212	1, 512, 116
1895	1, 575, 940	1, 625, 958	1, 681, 579	1, 590, 696
1896	1, 784, 104	1, 853, 757	1, 726, 332	1, 699, 818
1897	1, 668, 286	1, 647, 363	1, 604, 954	1, 563, 483
1898	1, 352, 086	1, 504, 613	1, 352, 126	1, 269, 282
1899	1, 216, 916	1, 201, 669	1, 243, 689	1, 213, 368

Total product of crude pretroleum in the Pennsylvania and New York oil fields from 1871 to 1899, by months and years—Continued.

[Barrels of 42 gallons.]

Year.	October.	November.	December.	Total.
1871	485, 243	564, 610	477, 958	5, 205, 234
1872	442, 432	638, 610	645, 575	6, 293, 194
1873	942, 493	991, 470	1, 084, 380	9, 893, 786
1874	919, 739	861, 060	858, 142	10, 926, 945
1875	731, 073	700, 200	720, 874	8, 787, 514
1876	809, 162	786, 480	787, 090	8, 968, 906
1877	1, 269, 326	1, 173, 420	1, 256, 058	13, 135, 475
1878	1, 369, 797	1, 348, 950	1, 318, 678	15, 163, 462
1879	1, 836, 378	1, 710, 480	1, 769, 356	19, 685, 176
1880	2, 385, 636	2, 274, 420	2, 238, 634	26, 027, 631
1881	2, 323, 171	2, 266, 830	2, 480, 000	27, 376, 509
1882	2, 297, 658	2, 192, 940	1, 897, 510	30, 053, 500
1883	2, 076, 659	1, 958, 340	1, 988, 526	23, 128, 389
1884	1, 961, 866	1, 811, 700	1, 822, 614	23, 772, 209
1885	1, 874, 105	1, 761, 660	1, 898, 657	20, 776, 041
1886	2, 408, 111	2, 222, 790	2, 181, 625	25, 798, 000
1887	1, 843, 291	1, 125, 450	1, 288, 602	*a* 21, 478, 883
1888	1, 304, 518	1, 442, 405	1, 582, 741	16, 488, 668
1889	1, 959, 169	1, 913, 871	2, 055, 247	21, 487, 435
1890	2, 750, 698	2, 575, 941	2, 626, 035	*b* 29, 130, 910
1891	3, 575, 911	3, 834, 262	3, 578, 460	33, 009, 236
1892	2, 072, 022	1, 950, 553	1, 937, 986	28, 422, 377
1893	1, 616, 391	1, 533, 555	1, 616, 143	20, 314, 513
1894	1, 640, 982	1, 527, 752	1, 598, 282	19, 019, 990
1895	1, 621, 216	1, 594, 773	1, 692, 012	19, 144, 390
1896	1, 746, 257	1, 642, 846	1, 744, 257	20, 584, 421
1897	1, 605, 362	1, 538, 117	1, 524, 630	19, 262, 066
1898	1, 270, 455	1, 230, 063	1, 280, 054	15, 948, 464
1899	1, 229, 374	1, 205, 123	1, 165, 314	14, 374, 512

a Not including 877,310 barrels dump oil and oil shipped by private lines. *b* Pipe-line runs.

In the following table is given a statement of the average daily production of crude petroleum in the Pennsylvania and New York oil fields for each month from 1871 to 1899. It is well to repeat here that this table is not the same as the daily average receipts published by the pipe lines, but the average daily production, the total production including some oil that is not reported in the daily returns of the pipe lines. The averages are obtained by dividing the product of each

month, in the table given elsewhere, by the number of days in each month, and the production of the year by 365 or 366, as the case may be.

Average daily product of crude petroleum in the Pennsylvania and New York oil fields each month for the years 1871 to 1899, by months and years.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1871	13, 497	13, 306	12, 914	12, 866	13, 187
1872	18, 825	15, 965	14, 890	15, 403	17, 326
1873	20, 407	21, 725	21, 461	21, 384	25, 044
1874	37, 653	29, 839	28, 598	25, 958	28, 895
1875	27, 489	25, 708	25, 469	22, 502	22, 468
1876	22, 975	23, 065	23, 167	23, 383	23, 721
1877	27, 190	27, 979	29, 087	32, 427	36, 374
1878	38, 816	39, 102	38, 980	39, 863	40, 802
1879	44, 191	43, 515	48, 365	51, 015	53, 062
1880	61, 423	64, 552	65, 032	67, 190	71, 901
1881	72, 390	68, 326	73, 372	73, 526	77, 203
1882	75, 921	76, 119	80, 070	80, 093	80, 212
1883	62, 849	62, 721	59, 054	60, 551	63, 292
1884	58, 898	64, 850	66, 202	68, 862	76, 834
1885	53, 296	51, 353	52, 843	59, 343	59, 141
1886	56, 418	57, 316	62, 208	64, 612	70, 283
1887	64, 221	65, 283	64, 716	65, 372	64, 307
1888	37, 228	44, 508	43, 190	44, 980	47, 528
1889	49, 768	47, 589	52, 537	54, 531	58, 767
1890	68, 008	73, 408	74, 619	77, 629	76, 722
1891	91, 293	81, 690	76, 129	77, 917	73, 828
1892	89, 888	93, 230	85, 724	85, 827	80, 163
1893	55, 610	59, 701	61, 302	56, 076	56, 505
1894	50, 949	51, 152	53, 632	51, 250	52, 521
1895	50, 669	47, 083	51, 093	55, 215	52, 607
1896	53, 173	52, 338	52, 653	61, 419	56, 325
1897	51, 345	55, 589	55, 823	53, 721	52, 243
1898	46, 103	45, 141	47, 276	45, 323	44, 237
1899	37, 302	37, 266	40, 442	40, 119	40, 064

Average daily product of crude petroleum in the Pennsylvania and New York oil fields each month for the years 1871 to 1899, by months and years—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.
1871	13,678	14,725	14,922	15,398
1872	16,371	16,702	17,739	16,681
1873	26,449	27,983	30,198	31,809
1874	30,725	33,337	30,049	28,021
1875	23,207	25,431	23,186	23,298
1876	24,120	24,633	25,233	26,020
1877	37,693	38,335	41,089	40,497
1878	40,575	41,415	43,288	43,857
1879	55,855	56,057	61,042	61,890
1880	71,948	72,530	75,517	78,210
1881	79,262	76,538	75,217	73,114
1882	94,198	105,102	100,145	87,346
1883	65,930	65,174	60,627	63,779
1884	62,073	66,450	67,715	64,942
1885	58,907	57,284	55,031	57,093
1886	77,846	78,031	78,426	80,618
1887	63,762	61,275	59,641	59,321
1888	48,357	44,995	44,661	42,436
1889	60,382	63,037	63,362	62,254
1890	79,000	81,426	81,128	86,165
1891	77,233	73,842	79,787	94,585
1892	81,312	76,158	75,116	70,850
1893	59,361	55,487	54,569	53,801
1894	55,465	52,412	52,007	50,404
1895	52,531	52,450	54,244	53,023
1896	59,470	59,799	55,688	56,661
1897	55,610	53,141	51,773	52,116
1898	45,070	42,084	43,617	42,309
1899	40,564	38,763	40,119	40,446

Average daily product of crude petroleum in the Pennsylvania and New York oil fields each month for the years 1871 to 1899, by months and years—Continued.

[Barrels of 42 gallons.]

Year.	October.	November.	December.	Yearly average.
1871	15, 653	15, 487	15, 418	14, 261
1872	14, 272	21, 287	20, 825	17, 194
1873	30, 403	33, 049	34, 980	27, 106
1874	29, 669	28, 702	27, 682	29, 937
1875	23, 583	23, 340	23, 254	24, 075
1876	26, 102	26, 216	25, 390	24, 505
1877	40, 946	39, 114	40, 518	35, 988
1878	44, 187	44, 965	42, 538	41, 544
1879	59, 238	57, 016	57, 076	54, 206
1880	76, 956	75, 814	72, 214	71, 114
1881	74, 941	75, 561	80, 000	75, 004
1882	74, 118	73, 098	61, 210	82, 338
1883	66, 989	65, 278	64, 146	63, 365
1884	63, 286	60, 390	58, 794	65, 129
1885	60, 455	58, 722	61, 247	56, 921
1886	77, 681	74, 093	70, 375	70, 679
1887	61, 822	37, 515	41, 568	58, 846
1888	43, 694	48, 080	51, 057	45, 058
1889	63, 199	63, 796	66, 298	58, 869
1890	88, 732	85, 865	84, 710	79, 810
1891	115, 352	127, 809	115, 434	90, 436
1892	66, 839	65, 018	62, 516	77, 657
1893	52, 142	51, 119	52, 133	55, 656
1894	52, 935	50, 925	51, 557	52, 110
1895	52, 299	53, 159	54, 581	52, 450
1896	56, 331	54, 762	56, 266	56, 241
1897	51, 786	51, 270	49, 182	52, 773
1898	40, 982	41, 002	41, 292	43, 694
1899	39, 657	40, 171	37, 591	39, 382

SHIPMENTS OF PETROLEUM FROM PENNSYLVANIA, NEW YORK, AND WEST VIRGINIA.

The following table gives the number of barrels of crude petroleum shipped out of New York, Pennsylvania, and West Virginia either by pipe lines, railways, or river, from 1871 to 1899, inclusive:

Shipments of crude and refined petroleum, reduced to crude equivalent, out of the Pennsylvania, New York, and West Virginia oil fields from 1871 to 1899, by months and years.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1871....	437,691	347,718	383,890	389,147	587,375
1872....	476,966	407,606	276,220	428,512	510,417
1873....	573,124	527,440	668,374	708,191	768,176
1874....	843,663	501,220	518,246	803,409	899,027
1875....	453,095	327,776	693,918	729,581	681,679
1876....	677,289	519,193	623,762	603,037	646,150
1877....	743,461	484,904	913,919	903,526	1,234,324
1878....	775,791	774,234	741,512	846,632	960,894
1879....	663,998	702,729	973,879	1,136,188	1,331,469
1880....	1,650,409	1,395,151	1,613,371	842,268	1,095,259
1881....	1,061,617	915,028	1,276,746	1,348,398	1,563,436
1882....	1,657,067	1,787,909	1,718,956	1,678,134	1,827,356
1883....	1,357,815	1,250,824	1,641,899	1,908,379	1,995,634
1884....	1,686,961	1,723,261	1,873,890	1,643,336	1,899,329
1885....	1,804,028	1,895,021	1,887,034	1,823,726	2,097,099
1886....	1,991,561	2,032,794	2,055,750	2,070,468	2,032,672
1887....	2,312,067	1,995,757	2,332,324	1,938,278	2,328,564
1888....	2,265,109	2,163,957	1,979,753	1,928,435	1,773,994
1889....	2,388,609	2,272,060	2,263,009	2,236,004	2,256,122
1890....	2,637,339	2,146,108	2,148,977	2,317,410	2,474,966
1891....	2,421,419	2,143,611	2,429,664	2,155,511	2,072,139
1892....	2,418,231	2,441,346	2,584,312	2,336,821	2,277,775
1893....	2,950,184	2,578,185	2,835,719	2,660,292	3,031,362
1894....	3,138,356	2,652,063	2,909,720	2,844,534	2,817,415
1895....	3,136,494	2,805,695	2,605,078	2,780,249	2,844,465
1896....	2,539,390	2,249,302	2,437,026	2,226,204	2,417,564
1897....	2,535,553	2,309,050	2,771,647	2,451,242	2,546,296
1898....	2,909,075	2,133,380	2,627,744	2,422,053	2,393,831
1899....	2,484,453	1,905,543	2,635,403	2,379,075	2,579,287

Shipments of crude and refined petroleum, reduced to crude equivalent, etc.—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.
1871	501, 754	541, 137	528, 134	551, 075
1872	529, 228	591, 238	621, 954	541, 607
1873	696, 414	814, 449	864, 768	952, 955
1874	815, 413	940, 281	793, 865	1, 014, 570
1875	745, 986	904, 537	882, 089	1, 109, 392
1876	921, 862	1, 228, 539	1, 203, 402	1, 154, 549
1877	1, 391, 124	1, 096, 951	1, 425, 943	1, 563, 797
1878	1, 135, 119	1, 330, 454	1, 655, 651	1, 434, 225
1879	1, 369, 314	1, 625, 035	1, 808, 239	1, 627, 120
1880	975, 083	1, 231, 611	1, 394, 129	1, 252, 635
1881	1, 729, 697	1, 925, 532	2, 214, 877	2, 131, 950
1882	2, 172, 685	2, 402, 970	2, 047, 545	1, 992, 171
1883	1, 747, 789	1, 634, 407	2, 086, 478	2, 325, 574
1884	1, 827, 553	1, 740, 021	2, 000, 371	2, 292, 087
1885	2, 034, 025	1, 961, 152	2, 049, 099	2, 116, 659
1886	2, 117, 489	2, 418, 961	2, 059, 299	2, 157, 323
1887	2, 165, 439	2, 000, 173	2, 220, 768	2, 342, 227
1888	1, 956, 115	2, 098, 531	2, 223, 263	2, 289, 486
1889	2, 268, 280	2, 949, 597	2, 625, 825	2, 567, 459
1890	2, 486, 205	2, 640, 668	2, 538, 224	2, 648, 418
1891	2, 122, 085	2, 260, 176	2, 496, 255	2, 701, 461
1892	2, 070, 396	2, 312, 571	2, 624, 488	2, 738, 369
1893	3, 073, 319	3, 318, 633	3, 248, 286	2, 998, 775
1894	2, 913, 440	2, 924, 466	3, 254, 087	2, 963, 025
1895	2, 814, 942	2, 634, 296	2, 422, 969	2, 330, 147
1896	2, 248, 761	2, 540, 332	2, 404, 063	2, 542, 363
1897	2, 554, 516	2, 707, 317	3, 098, 793	2, 953, 713
1898	2, 435, 192	2, 563, 771	2, 695, 972	2, 585, 205
1899	2, 538, 868	2, 357, 693	2, 779, 458	2, 704, 354

Shipments of crude and refined petroleum, reduced to crude equivalent, etc.—Continued.

[Barrels of 42 gallons.]

Year.	October.	November.	December.	Total.
1871	505, 071	480, 977	410, 822	5, 664, 791
1872	607, 468	477, 945	430, 786	5, 899, 947
1873	1, 010, 852	959, 589	955, 443	9, 499, 775
1874	543, 341	546, 117	602, 348	8, 821, 500
1875	871, 917	671, 066	871, 902	8, 942, 938
1876	524, 190	871, 496	1, 190, 983	10, 164, 452
1877	1, 268, 971	1, 205, 634	600, 019	12, 832, 573
1878	1, 747, 390	1, 281, 410	992, 688	13, 676, 000
1879	1, 662, 269	1, 453, 645	1, 532, 585	15, 886, 470
1880	1, 665, 933	1, 226, 030	1, 335, 613	15, 677, 492
1881	2, 080, 467	2, 066, 906	1, 969, 581	20, 284, 235
1882	2, 089, 428	1, 404, 640	1, 121, 453	21, 900, 314
1883	2, 215, 421	2, 065, 602	1, 749, 547	21, 979, 369
1884	2, 510, 283	2, 078, 261	2, 382, 244	23, 657, 597
1885	2, 050, 150	1, 857, 080	2, 138, 253	23, 713, 326
1886	2, 441, 848	2, 724, 796	2, 550, 891	26, 653, 852
1887	2, 573, 008	3, 462, 082	2, 608, 341	27, 279, 028
1888	1, 558, 115	2, 503, 491	2, 397, 782	25, 138, 031
1889	2, 747, 284	2, 393, 131	2, 671, 518	29, 638, 892
1890	2, 725, 341	2, 662, 898	2, 689, 521	30, 116, 075
1891	2, 799, 214	2, 601, 434	2, 781, 530	28, 984, 400
1892	2, 820, 735	2, 911, 907	2, 972, 479	30, 539, 430
1893	3, 314, 390	3, 092, 039	3, 149, 675	36, 250, 859
1894	3, 266, 994	3, 204, 296	3, 282, 089	36, 170, 481
1895	2, 569, 738	2, 648, 609	2, 406, 751	31, 999, 433
1896	2, 602, 853	2, 499, 474	2, 611, 511	29, 318, 843
1897	3, 634, 805	3, 316, 574	2, 761, 749	33, 641, 255
1898	2, 847, 002	2, 408, 069	2, 383, 925	30, 405, 216
1899	2, 743, 677	2, 607, 901	2, 600, 985	30, 316, 697

In the early history of the oil business a large percentage of the crude oil went direct from the field to the refineries, either by wagon, boat, or railway, and was lost sight of until shipped as refined oil, which was reduced to the equivalent of crude petroleum by allowing one barrel of crude to produce three-fourths of a barrel of refined, or a barrel of refined was regarded as being the equivalent of one and one-third barrels of crude. Since 1888 nearly the entire amount of crude petroleum has passed through the pipe lines, and is given under the head of "Shipments from the Appalachian field by months."

WELLS COMPLETED IN PENNSYLVANIA, NEW YORK, WEST VIRGINIA, AND THAT PART OF OHIO INCLUDED IN THE SOUTHWESTERN FIELD.

In the earlier years of petroleum production almost all of the product came from New York and Pennsylvania. These points were so far isolated that it was not difficult to keep them separated, so for a number of years there was a correct table of wells drilled in Pennsylvania and New York. In after years oil was found in Ohio near Macksburg and Marietta, and on the Little Kanawha River in West Virginia. Now it is almost one continuous field from western New York to the Little Kanawha River of West Virginia, a part extending over into Ohio from West Virginia at and near Sistersville, on the Ohio River. The following table includes the wells drilled in this portion of Ohio:

Number of wells completed in Pennsylvania, New York, West Virginia, and that part of Ohio included in the southwestern district each month from 1872 to 1899.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872.	37	120	89	121	135	84	128	118	82	100	64	105	1,183
1873.	93	94	100	105	102	130	114	120	106	101	100	98	1,263
1874.	102	104	110	113	109	101	121	107	104	120	106	120	1,317
1875.	190	187	195	186	172	190	200	210	201	220	217	230	2,398
1876.	240	231	242	200	202	261	248	270	209	273	272	272	2,920
1877.	281	241	291	269	320	403	317	255	322	467	391	382	3,929
1878.	274	226	211	409	470	269	203	186	174	229	248	165	3,064
1879.	136	132	238	270	402	330	327	283	210	232	227	261	3,048
1880.	320	230	367	500	426	310	338	368	356	364	336	302	4,217
1881.	222	220	271	316	406	374	336	332	312	322	363	406	3,880
1882.	347	340	385	432	469	340	185	253	164	117	150	122	3,304
1883.	125	126	142	209	231	228	261	309	321	321	302	272	2,847
1884.	229	227	256	298	311	244	268	145	89	59	73	66	2,265
1885.	64	62	82	116	213	242	217	283	356	397	384	345	2,761
1886.	270	280	291	328	343	365	357	313	253	272	221	185	3,478
1887.	158	162	138	160	148	162	159	142	134	100	101	96	1,660
1888.	57	52	56	49	56	97	82	96	132	229	307	302	1,515
1889.	284	288	353	401	431	537	549	508	478	559	540	471	a5,435
1890.	553	482	522	556	534	571	555	579	571	567	520	348	6,358
1891.	310	243	275	288	314	304	334	333	281	237	245	197	3,361
1892.	175	171	137	167	170	154	174	141	142	158	160	143	1,892
1893.	125	84	130	127	172	213	193	145	158	139	137	167	1,790
1894.	180	170	202	261	307	349	319	341	362	373	368	316	3,548
1895.	271	195	324	425	601	754	772	766	735	686	613	534	6,676
1896.	537	514	499	569	658	744	673	589	594	581	622	625	7,205
1897.	544	408	368	428	485	553	603	557	455	417	404	352	5,574
1898.	326	255	275	329	329	364	391	417	475	533	532	570	4,796
1899.	583	454	626	616	751	809	751	765	803	886	895	813	8,752

a Includes 36 wells drilled in Franklin district, data for which by months was not obtainable.

SOUTHEASTERN OHIO.

That portion of Ohio known as the Southeastern division, which includes that part of the Appalachian field located in Ohio, is discussed farther on in this report in connection with the Lima-Indiana field.

WEST VIRGINIA.

Of the States producing Appalachian or Pennsylvania petroleum this is the only one that in 1899 showed an increase, although the rate of gain over 1898 was only 2.17 per cent, as compared with 4 per cent in 1898 over that of 1897. It likewise leads all other States in the production of this class of oil.

For the past three years the output has been remarkably regular and slightly on the increase. The indications are that this production will be more than maintained for a number of years. The great depth at which most of the oil is found in this State tends to prevent too great a crowding of wells.

Considerable new territory and extensions of established lines were developed during the past year and a number of large wells opened up, but the new production was nearly offset by the decline of wells in the older fields.

The opening up of a deep sand pool near Garner, east of Proctor, in Wetzel County; the northern extension of the Campbells Run pool toward the Pennsylvania State line; the opening up of the shallow sand territory in Pleasants and Wood counties; the large production of a number of Big Injun wells west and northwest of Stringtown, in Tyler County, together with the extension of the Elk Fork pool to the northeast in the same county, and the opening up of a new deep sand pool in Doddridge County, known as the "Stout pool," are the most important events of the year, and have added a large amount of new production to the output of the State.

Wetzel County continues to furnish large quantities of both oil and gas, principally from the Big Injun, "stray," and Gordon sands near the bottom of the great Appalachian coal basin, where slight crumples and folds, together with a gradual rise to the west and northwest, have given sufficient difference in elevation to concentrate both the oil and gas. Large areas are comparatively free from salt water in the lower sands.

The main production is in a large basin where the northeast and southwest axis crosses Fishing Creek, 1½ miles west of the mouth of Archers Fork, at which point the Pittsburg coal is 180 feet above tide. This same elevation continues northeast about 2 miles, and from the same point southwest about 5 miles, lapping over into Tyler County, rising at both the ends of this line. The slopes rising from this axis line to the east are quite flat, so that in a general way a distance of 2 miles will be traveled around this axis line until the Pittsburg coal

climbs to the elevation of 200 feet above tide. On the western and southern edge of this elliptical basin in the distance of about half a mile the coal has risen to 250 feet above tide. Between this last elevation and 190 feet, extending more than halfway around on these contours, to northeast, northwest, and southwest, nearly all of the producing territory in the basin outlined is found. There are elevations further west in which the Pittsburg coal is from 300 to 350 feet above tide which contain reservoirs of gas, as do many of the minor puckers and folds farther down toward the bottom of this basin.

The thinning of the strata toward the southwest has no doubt increased the dip considerably toward the center of the basin.

The distance from the Pittsburg coal to the Gordon sand in the eastern margins of this basin is about 2,100 feet, as compared with 2,050 feet toward the southwestern margin. It is separated from the stray or 30-foot sand by a break of slate from 5 to 15 feet thick.

The Big Injun sand, the stray, and the so-called Gordon are the sands in which almost all of the oil in this county is found, the latter sand furnishing a larger proportion of the total. The average depth of the Gordon sand wells is about 3,000 feet in this section, and the Gordon sand will average about 2,275 feet below tide in this county.

Monongalia County has produced a number of large wells in the extension of the Campbells Run and Flat Run pools to the northeast toward the Pennsylvania line. Several large wells have been found just south of the line in what seems to correspond with the fifth sand, in which usually three pays are discovered. The general trend of the Campbells Run line of production is northeast from near Glovers Gap, in Marion County, to the Pennsylvania State line. It follows close to the bottom of a shallow trough whose axis rises as the State line is approached.

There have been a number of good wells found in this county in the extension of the Flat Run pool, which follows in a measure parallel to the Campbells Run line, but several miles to the east.

Marion County has contributed a number of good wells in territory that was formerly well defined.

Harrison County has furnished more new territory and has been the center of a large amount of field work during the past year.

The Jarvisville or Wolf Summit pool at the beginning of 1899 had only a few producing wells of insignificant output. By the close of the year one of the most important pools in the State was partially developed. During the year the pool has been extended from near Jarvisville northeast, crossing the Baltimore and Ohio Railroad 1½ miles west of Wolf Summit and advancing 1½ to 2 miles beyond the railroad, with the end not yet in sight.

This pool of petroleum was first developed in a well drilled southwest of Jarvisville in search of gas along the sharp dips to the west.

The axis of the Campbells Run development southwest crosses the Baltimore and Ohio Railroad about 1½ miles west of Salem, the bottom of the basin here rising to the southwest from an elevation of 180 feet, to where the Pittsburg coal is about 250 feet above tide. To the east about 9 miles the Wilsonburg arch crosses the railroad, the Pittsburg coal having risen to about 1,200 feet above tide, a rise of about 100 feet to the mile on the average. From a short distance east of Cherry Camp to Wolf Summit it amounts to more than 400 feet in 3 miles.

Along the flank of this steep dip, where the elevation of the Pittsburg coal is from 700 to 800 feet above tide, extending in a general way north 30° east, 2 miles from the railroad and 6 miles south 30° west of the railroad, the deposit of petroleum is found. The sand in which the production is found is 160 feet below the Gordon sand, and is probably the fifth, the interval having enlarged from 110 to 160 feet toward the southeast.

The sand is of a dark-reddish color and does not differ much from the color and texture of the "Bradford sand." There is a hard cap of from 6 inches to 1 foot on top, the balance being quite soft, and the thickness is from 3 to 12 feet. A number of good gas wells have been developed near the town of Clarksburg in the lower group of sands lately developed by the deep wells near Jarvisville, and several large gas wells have been found to the east of the oil pool, near the Wilsonburg arch.

Lewis County created the most excitement in 1899 of any county in West Virginia by a well drilled on the Cameron tract, 5 miles west of Weston, early in October, which began flowing at the rate of 300 barrels per day from one of the sands above the "Big Lime." In a few days it had declined to 20 barrels per day. This well was some 15 miles southeast from the nearest producing well in the Jarvisville pool and was a genuine surprise.

It was located on the Chestnut Ridge axis not far from where it intersects with the Wilsonburg axis, the elevation of the Pittsburg coal being 1,300 feet above tide at this well.

This strike caused a large amount of drilling to be done. The general results, however, have so far been unsatisfactory. Near the extreme southeastern corner of the county some oil has been found in the salt sand at about 430 feet in depth. Operations in the oil pool in the northwest portion of this county, on the headwaters of Fink Creek, continue without special change.

Tyler County during 1899 produced some fine wells in the northeastern extension of the old Elk Fork pool, but not enough to compensate for the fast declining production of the older portion. In this field the Keener sand was found at a comparatively shallow depth, and many more wells were drilled than was necessary, but to help secure the greatest amount of oil in the shortest time possible nearly all of the wells were severely torpedoed.

Some fairly good wells have been developed in the Wick and Hebron pools. In the latter, several good shallow-sand producers were found, but by far the most important were discovered in the Big Injun sand to the west and northwest of Stringtown. Several of these wells put out an average of 350 barrels a day for the first month. A number of powerful gas wells were struck to the southeast of the Elk Fork oil pool.

Doddridge County was conspicuous owing to the development of a deep-sand pool in the southwestern section, on the headwaters of the Hughes River, where a number of good wells were procured. None of them so far have developed the gusher qualities of many of the deep-sand wells in Wetzel and Marion counties.

The Whiskey Run pool developed in the northeastern portion of Ritchie County in 1898 had commenced to decline during the latter part of that year. This decline was continued, so that the production of this field, which put 85,000 barrels to its credit in May, 1898, has declined to about one-tenth that amount per month in 1899. A number of good wells have been found in the salt and Big Injun sands in the region surrounding Cairo, Cornwallis, and Ritchie mines; yet generally the wells have been small, and a number of them have proved destitute of oil in paying quantities.

Pleasants County has produced a large amount of oil from shallow-sand wells, mostly from the second Cow Run sand. Territory that had lain neglected for a long time proved to be very profitable owing to the shallow depth at which the oil was found. There were many dry holes, and the producing areas were often dotted over with them; yet the cost of a dry hole did not represent a large amount of loss as compared with other sections where deep drilling was necessary to reach the oil-producing formation. Many of these pools of shallow sand were opened up on the waters of Middle Island, French Creek, and Cow Creek, and very satisfactory returns were secured.

The Ogden and Hendershot pools, in Wood County, that obtain their oil from the Berea sand, have been on a gradual decline, and only a few profitable wells along the edges of these pools were developed in 1899.

The shallow-sand development on Big Run produced some remarkable wells from that sand. Several of them started at the rate of 500 barrels per day.

That portion of West Virginia lying south of the Little Kanawha River has produced no petroleum in merchantable quantities excepting in Roane County, where several paying wells were discovered some 10 miles south of Spencer.

The great thickening of the strata toward the south and southwest from the Pittsburg coal to the oil-sand group over this section and the thinning out of the oil-sand group seem unfavorable for the accumulation of petroleum.

A number of fairly good gas wells have been found scattered over this area, but the dry holes far outnumber the producing wells.

PRODUCTION.

The production of crude petroleum in West Virginia, by months, from 1890 to 1899, is shown in the following table:

Total production of crude petroleum in West Virginia, by months, from 1890 to 1899.

[Barrels of 42 gallons.]

Month.	1890.	1891.	1892.	1893.	1894.
January	38,644	48,902	195,512	577,933	838,400
February	38,061	123,841	186,455	468,794	684,532
March	44,842	229,966	185,468	630,877	754,398
April	39,804	226,020	181,708	594,190	688,458
May	39,160	232,076	206,142	705,714	742,701
June	35,610	223,734	261,900	682,040	699,498
July	34,096	221,127	328,485	724,494	767,728
August	31,505	238,451	411,114	843,706	717,844
September	50,342	219,528	420,882	847,558	674,791
October	46,387	220,076	451,157	792,719	694,187
November	45,062	207,477	467,446	757,170	654,887
December	49,065	215,020	513,817	820,217	660,200
Total	492,578	2,406,218	3,810,086	8,445,412	8,577,624

Month.	1895.	1896.	1897.	1898.	1899.
January	647,220	757,574	869,210	1,207,645	1,117,420
February	541,511	729,229	844,833	1,036,382	990,935
March	642,222	785,261	938,673	1,215,958	1,122,351
April	646,862	799,509	942,252	1,149,462	1,072,326
May	670,330	855,699	1,016,213	1,160,991	1,163,799
June	621,733	853,224	1,063,053	1,065,999	1,153,791
July	742,326	843,872	1,142,045	1,104,530	1,171,061
August	734,517	874,595	1,283,358	1,134,236	1,278,290
September	717,170	876,308	1,254,770	1,133,592	1,175,046
October	713,138	884,716	1,269,522	1,130,713	1,222,690
November	721,411	851,488	1,261,766	1,116,752	1,217,905
December	721,685	908,295	1,204,350	1,158,841	1,225,016
Total	8,120,125	10,019,770	13,090,045	13,615,101	13,910,630

Total amounts and values of crude petroleum produced in West Virginia from 1889 to 1899, inclusive.

Year.	Regular crude.			Lubricating crude.			Total.		
	Production.	Value.	Price per barrel.	Production.	Value.	Price per barrel.	Production.	Value.	Price per barrel.
	Barrels.			*Barrels.*			*Barrels.*		
1889......	520,511	$595,730	$1.145	23,602	$58,097	2.46\frac{1}{8}$	544,113	$653,827	1.20\frac{1}{8}$
1890......	....	....	....	....	....	....	492,578	501,198	1.01$\frac{3}{4}$
1891......	....	....	....	....	....	....	2,406,218	1,612,826	.67
1892......	....	....	....	....	....	....	3,810,086	2,119,901	.556
1893......	8,433,412	5,398,522	.64	12,000	27,000	2.25	8,445,412	5,425,522	.64
1894......	8,563,954	7,182,794	.839	13,670	38,923	2.85	8,577,624	7,221,717	.84
1895......	8,109,782	11,017,651	1.35$\frac{2}{7}$	10,343	21,119	2.04	8,120,125	11,038,770	1.36
1896......	10,005,966	11,794,532	1.17$\frac{7}{8}$	13,804	35,086	2.54	10,019,770	11,829,618	1.18
1897......	13,078,011	10,282,586	.78$\frac{5}{8}$	12,034	27,592	2.29	13,090,045	10,310,178	.78$\frac{3}{4}$
1898......	13,603,136	12,395,858	.91$\frac{1}{3}$	11,965	30,501	2.55	13,615,101	12,426,359	.913
1899......	13,892,906	17,973,947	1.29$\frac{3}{8}$	17,724	40,819	2.303	13,910,630	18,014,766	1.295

In 1899 the quantity of petroleum produced in West Virginia increased only 2.17 per cent as compared with the production in 1898, while the receipts increased $5,588,407, amounting to a gain of 45 per cent, and over $1,500,000 must have been returned to the landowners without any outlay on their part.

In the following table is given the production of oil in West Virginia from the beginning of operations, so far as obtainable (that previous to 1877 being partially estimated), from 1876 to 1899:

Production of petroleum in West Virginia.

Year.	Barrels.	Year.	Barrels.	Year.	Barrels.
Previous to 1876..	3,000,000	1884......	90,000	1894......	8,577,624
1876......	120,000	1885......	91,000	1895......	8,120,125
1877......	172,000	1886......	102,000	1896......	10,019,770
1878......	180,000	1887......	145,000	1897......	13,090,045
1879......	180,000	1888......	119,448	1898......	13,615,101
1880......	179,000	1889......	544,113	1899......	13,910,630
1881......	151,000	1890......	492,578	Total..	87,815,150
1882......	128,000	1891......	2,406,218		
1883......	126,000	1892......	3,810,086		
		1893......	8,445,412		

WELL RECORDS OF WEST VIRGINIA.

The operations in the West Virginia oil fields are included under the head of the Southwest division in the general summaries of the Pennsylvania or Appalachian region. The fact that the northeastern end of the Mannington district overlaps into Pennsylvania and that a large portion of the Sistersville field lies in southeastern Ohio makes it rather difficult to determine the exact number of wells completed that should be credited to West Virginia. In the following tables the records of the principal producing sections of the West Virginia oil fields are presented. It should be borne in mind that a portion of the wells credited to Sistersville belong in southeastern Ohio and that some of those credited to the Mannington district are located along the southern border of Pennsylvania.

Total number of wells drilled in West Virginia in 1899, by months and districts.

Month.	Sistersville.	Mannington.	Wood County.	Pleasants County.	Ritchie County.	Burning Springs.	Miscellaneous.	Total.
January	32	81	38	24	12	4	0	191
February	23	59	17	23	9	3	4	138
March	30	74	23	23	16	4	0	170
April	35	51	24	25	13	5	1	154
May	28	71	59	23	13	4	0	198
June	44	63	32	33	12	6	0	190
July	33	79	25	38	21	4	0	200
August	38	73	32	29	18	8	2	200
September	50	65	21	46	22	9	9	222
October	72	101	43	32	9	6	4	267
November	60	86	29	57	13	5	5	255
December	69	75	27	40	11	4	1	227
Total	514	878	370	393	169	62	26	2,412
Total for 1898	225	681	391	135	220	34	14	1,700
Difference	289	197	21	258	51	28	12	712

It will be seen that nearly every section of the West Virginia oil fields registered an increase during 1899 and that the total number of wells drilled exceeded those of 1898 by 712. Notwithstanding this fact, the net increase in the production of West Virginia in 1899 was but 2.17 per cent. The drilling of 2,412 new wells in 1899, 1,863 of which were productive of oil in paying quantities, resulted in increasing the total production of the year only 295,529 barrels. About two-thirds of the wells credited to the Sistersville district were completed on the Ohio side of the river.

Number of wells completed in West Virginia from 1893 to 1899, by districts.

District.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Burning Springs	......	....	....	12	37	34	62
Mannington	97	254	472	419	709	681	878
Pleasants County	......	....	....	103	85	135	393
Ritchie County	......	....	....	40	186	220	169
Roane County	......	....	....	....	....	14	3
Sistersville	465	400	588	620	303	225	514
Wirt County	......	....	....	....	....	....	2
Wood County	......	39	....	282	373	391	370
Miscellaneous	34	50	251	130	....	....	21
Total	596	743	1,311	1,606	1,693	1,700	2,412

During 1899 there were 26 miscellaneous wells drilled in the State, as compared with 14 drilled in 1898.

Number of wells completed in West Virginia from 1893 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1893.	50	32	53	55	61	68	52	44	50	39	45	47	596
1894.	44	49	45	50	69	69	66	56	59	84	96	56	743
1895.	61	43	68	72	83	112	119	151	147	146	150	159	1,311
1896.	140	133	112	113	127	160	141	128	135	111	160	146	1,606
1897.	129	105	77	114	120	159	177	186	163	165	159	139	1,693
1898.	129	113	95	121	101	130	144	133	174	183	176	201	1,700
1899.	191	138	170	154	198	190	200	200	222	267	255	227	2,412

Initial production of wells completed in the West Virginia oil fields during the year 1899.

[Barrels of 42 gallons.]

Month.	Sisters-ville.	Man-nington.	Wood County.	Pleas-ants County.	Ritchie County.	Burning Springs.	Miscel-laneous.	Total.
January	375	3, 405	792	1, 245	143	13	0	5, 973
February	360	2, 303	500	885	123	9	0	4, 180
March	573	2, 445	350	645	200	13	0	4, 226
April	706	2, 099	545	720	225	24	0	4, 319
May	891	3, 133	1, 147	907	325	8	0	6, 411
June	1, 168	3, 077	566	1, 360	273	30	0	6, 474
July	953	3, 390	534	870	293	31	0	6, 071
August	916	3, 414	510	746	340	102	0	6, 028
September	1, 194	2, 614	280	1, 083	449	33	10	5, 663
October	1, 787	3, 957	774	910	95	21	0	7, 544
November	1, 442	2, 950	457	1, 458	150	26	20	6, 503
December	1, 897	2, 012	408	945	145	11	0	5, 418
Average	1, 021	2, 900	572	981	230	27	3	5, 734

Average initial daily production of wells completed in West Virginia from 1893 to 1899, by districts.

[Barrels of 42 gallons.]

District.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Burning Springs				2	10	12	27
Mannington	1, 293	1, 987	1, 759	1, 210	5, 074	3, 157	2, 900
Pleasants County				132	76	160	981
Ritchie County				51	492	745	230
Roane County						3	0
Sistersville	3, 453	1, 632	2, 057	1, 890	912	472	1, 021
Wirt County							0
Wood County		59		526	933	1, 145	572
Miscellaneous	25	44	317	121			3
Total	4, 771	3, 722	4, 133	3, 932	7, 497	5, 694	5, 734

Daily initial production of wells in West Virginia from 1893 to 1899, by months.

[Barrels of 42 gallons.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1893	4,278	4,660	4,592	4,425	4,088	5,250	4,920	7,055	4,490	2,914	4,705	5,875	4,771
1894	5,540	3,955	3,265	2,539	3,503	5,953	4,412	3,549	3,130	3,492	3,379	1,948	3,722
1895	2,410	1,255	2,156	2,584	2,042	4,064	3,054	6,599	9,846	5,985	5,717	3,883	4,133
1896	3,492	4,043	3,224	3,461	4,085	5,076	2,948	2,840	3,272	3,700	4,799	6,243	3,932
1897	5,306	5,294	2,751	5,408	5,828	8,876	9,940	12,556	10,117	7,691	8,512	7,688	7,497
1898	7,648	4,369	6,213	5,392	5,805	4,269	3,932	6,340	6,663	5,552	6,410	5,738	5,694
1899	5,973	4,180	4,226	4,319	6,411	6,474	6,071	6,028	5,663	7,544	6,503	5,418	5,734

Number of dry holes completed in the West Virginia oil fields during the year 1899.

Month.	Sistersville.	Mannington.	Wood County.	Pleasants County.	Ritchie County.	Burning Springs.	Wirt County.	Miscellaneous.	Total.
January	10	16	9	0	2	0	0	0	37
February	8	8	2	0	2	1	2	0	23
March	9	14	6	4	2	0	0	0	35
April	10	11	5	8	4	0	0	1	39
May	5	25	15	3	1	1	0	0	50
June	10	17	8	6	3	3	0	0	47
July	12	15	4	7	6	0	0	0	44
August	12	13	10	3	5	1	0	2	46
September	11	13	5	7	4	4	0	8	52
October	20	10	13	5	1	2	0	4	55
November	17	15	10	14	3	0	0	2	61
December	19	14	12	13	1	0	0	1	60
Total	143	171	99	70	34	12	2	18	549
Total for 1898	77	145	86	47	52	10	0	11	428
Difference	66	26	13	23	18	2	2	7	121

There were 121 more dry holes completed in the West Virginia oil districts in 1899 than in 1898.

Number of dry holes drilled in West Virginia from 1893 to 1899, by districts.

District.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Burning Springs	....	....	....	4	16	10	12
Mannington	22	65	106	110	128	145	171
Pleasants County	....	....	....	43	41	47	70
Ritchie County	....	....	....	17	40	52	34
Roane County	....	....	....	....	....	11	3
Sistersville	40	27	138	211	112	77	143
Wirt County	....	....	....	....	....	....	2
Wood County	....	27	....	62	85	86	99
Miscellaneous	13	22	83	43	....	....	15
Total	75	141	327	490	422	428	549

There were 15 dry holes drilled outside of the counties named in 1899 in West Virginia.

Number of dry holes drilled in West Virginia, 1893 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1893.	7	3	10	9	5	13	2	6	6	6	5	3	75
1894.	1	7	7	6	14	15	11	7	14	21	23	15	141
1895.	14	10	14	17	17	25	35	52	33	41	40	29	327
1896.	48	41	39	35	47	56	52	35	32	22	44	39	490
1897.	38	15	27	23	29	31	40	42	40	44	43	50	422
1898.	36	28	22	37	18	28	41	37	41	43	43	54	428
1899.	37	23	35	39	50	47	44	46	52	55	61	60	549

Wells in process of drilling in the West Virginia oil fields in 1899, by districts and months.

Month.	Sisters-ville.	Man-ning-ton.	Wood County.	Pleas-ants County.	Ritchie County.	Burn-ing Springs.	Roane County.	Wirt County.	Total.
January	20	144	23	10	14	3	3	1	218
February	12	136	21	8	16	2	1	0	196
March	17	124	25	10	15	1	1	0	193
April	19	139	19	5	15	2	0	0	199
May	31	141	18	9	9	2	0	0	210
June	32	159	19	11	20	4	0	0	245
July	37	147	18	8	11	6	0	0	227
August	31	150	10	17	16	6	0	0	230
September	36	170	17	8	7	4	0	0	242
October	39	155	17	18	13	3	0	0	245
November	45	157	20	7	9	4	0	0	242
December	40	159	12	11	10	6	0	0	238
Average	30	149	18	10	13	4	......	......	224

Average number of wells drilling in West Virginia, from 1893 to 1899, by districts.

District.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Burning Springs	......	......	......	1	3	2	4
Mannington	32	58	78	64	107	126	149
Pleasants County	......	......	......	5	6	8	10
Ritchie County	......	......	......	4	11	15	13
Roane County	......	......	......	......	......	1	......
Sistersville	42	34	59	56	24	15	30
Wirt County	......	......	......	......	......	......	......
Wood County	......	3	......	25	30	30	18
Miscellaneous	6	6	24	15	......	......	......
Total	80	101	161	170	181	197	224

Number of wells drilling in West Virginia, 1893 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1893.	71	88	64	82	78	83	83	70	82	82	96	86	80
1894.	81	74	72	86	92	105	108	126	124	122	100	121	101
1895.	66	104	99	116	152	179	188	187	206	222	230	186	161
1896.	151	142	141	167	167	184	182	193	157	201	182	177	170
1897.	172	136	168	158	188	193	203	193	205	187	182	183	181
1898.	159	142	150	148	196	188	191	224	238	240	257	235	197
1899.	218	196	193	199	210	245	227	230	242	245	242	238	224

Rigs building in the West Virginia oil field in 1899.

Month.	Sisters-ville.	Man-ning-ton.	Wood County.	Pleas-ants County.	Ritchie County.	Burn-ing Springs.	Roane County.	Wirt County.	Total.
January	27	43	18	9	6	1	1	2	107
February	36	41	16	13	7	3	1	1	118
March	25	37	19	7	4	4	1	1	98
April	20	40	21	3	1	0	0	0	85
May	17	41	16	8	7	4	0	0	93
June	17	38	13	1	4	4	0	0	77
July	21	33	14	2	10	2	0	0	82
August	31	41	13	5	8	3	0	0	101
September	31	44	11	5	11	4	0	0	106
October	35	54	15	8	6	3	0	0	121
November	32	42	10	22	8	5	0	0	119
December	54	62	11	13	10	4	0	0	154
Average	29	43	15	8	7	3	......	......	105

Average number of rigs building in West Virginia, 1893 to 1899, by districts.

District.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Burning Springs	....	....	....	....	1	1	3
Mannington	11	20	34	26	35	39	43
Pleasants County	....	....	....	3	2	3	8
Ritchie County	....	....	....	1	3	7	7
Roane County	....	....	....	....	....	1	....
Sistersville	24	25	47	39	22	18	29
Wirt County	....	....	....	....	....	....	....
Wood County	....	1	....	21	23	24	15
Miscellaneous	8	7	16	10	....	2	....
Total	43	53	97	100	86	95	105

Number of rigs building in West Virginia, 1893 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1893.	45	38	39	59	50	43	35	43	32	38	54	43	43
1894.	54	43	48	58	53	37	40	55	53	54	72	63	53
1895.	41	69	82	61	86	117	120	103	112	114	133	131	97
1896.	129	111	92	98	119	113	99	80	84	85	97	90	100
1897.	76	89	77	85	78	90	90	97	83	98	97	78	86
1898.	77	83	78	68	85	89	99	102	116	87	129	129	95
1899.	107	118	98	85	93	77	82	101	106	121	119	154	105

KENTUCKY.

Petroleum was produced in three counties in Kentucky in the year 1899, namely, Barren, Floyd, and Wayne. The production of Barren and Wayne counties was 18,280 barrels, valued at $17,256, or 94.4 cents a barrel. As there is no market for the petroleum in Floyd County the product was tanked. The product of Wayne County is piped by the Kentucky Oil and Pipe Line Company to Somerset. The following is a statement of runs made by this company during each month of 1899:

Pipe line runs in Wayne County, Kentucky, in 1899.

Month.	Barrels.	Month.	Barrels.
January	0	August	1,301.20
February	19.08	September	1,608.70
March	1,106.76	October	1,392.34
April	728.82	November	449.83
May	906.17	December	571.40
June	2,203.01	Total	12,183.82
July	1,896.51		

The prices paid for petroleum in Wayne County ranged from 85 cents in August to 65 cents in September, 90 cents in October, and $1 in December, the average for the year being 87 cents.

There have been drilled in Wayne County 56 wells, 32 of which have made fair shows of oil, but only 7 have been producing; some of the others have never been fully tested.

Four deep wells were drilled by the New Domain Oil and Gas Company in Pike County, and while a number of massive sandstone deposits were pierced, they were generally charged with salt water, with a small amount of gas in others. A very rapid thickening of the rocks toward the south was demonstrated, although the upper rocks showed a decided rise in a southern direction. The petroleum found on Right Beaver near the mouth of Salt Creek comes from the salt sand above the "big lime" and is of good quality, being a fair average of Pennsylvania oil. In Martin County several good gas wells were developed a few miles east of Eden, some of which gave indications of petroleum.

PRODUCTION.

The total production of oil in Kentucky, so far as has been ascertained, is as follows:

Production of petroleum in Kentucky from 1883 to 1899.

[Barrels of 42 gallons.]

Year.	Production.	Year.	Production.
Prior to 1883	160,933	1891	9,000
1883	4,755	1892	6,500
1884	4,148	1893	3,000
1885	5,164	1894	1,500
1886	4,726	1895	1,500
1887	4,791	1896	1,680
1888	5,096	1897	322
1889	5,400	1898	5,568
1890	6,000	1899	a 18,280
		Total	248,363

a In addition to this, 6,300 barrels were produced in Floyd County and tanked, none being sold.

The 228 per cent increase in the production of Kentucky is due to the construction of 35 miles of pipe line by the Kentucky Oil and Pipe Line Company from Slickford in Wayne County to Somerset on the Cincinnati Southern Railroad. There were 6,300 barrels produced and put into tanks in Floyd County in 1899, but none sold. Barren County produced 6,097 barrels and Wayne County 12,183 barrels, making a total of 24,580 barrels in 1899.

TENNESSEE.

The only production of Tennessee in 1899 was from the Bobs Bar well in Fentress County. This well was drilled in January, 1896, flowed 50 barrels per hour for fourteen hours, caught fire, burned the rig, and was not refitted and put to pumping until November of that year. Since then it has been pumped daily, except Sunday, but has been pumped part of the time only five hours each day. During 1899 it was pumped from seven to nine hours, making about 17 to 20 barrels daily, the product in the past year being 7,280 barrels, which is delivered regularly to the National Transit Company and tanked, the tankage capacity being 40,000 barrels. Up to the present time about 20,080 barrels have been produced from this well and tanked. None of it has been marketed. The Reagan well, just across the Obey River from the Bobs Bar well, has a production of 2 barrels per day. The Rock House well is still flowing a little oil. The Abe Beaty well, 1 mile south of the Bobs Bar well, continues to produce some gas. The David Beaty well in a recent test produced 3½ barrels per day. The production of the Lacy well is not known, as it has not yet been pumped. During the past two years three wells have been drilled in this section, none of which found oil in paying quantities. Several other wells have been drilled within a radius of 5 or 6 miles of the Bobs Bar well, most of which showed oil, but as there is no market for the product these wells have not been put in operation. There is some prospect of a pipe line being built connecting this territory with the end of the pipe line at Slickford, Kentucky, about 20 miles distant.

PRODUCTION OF APPALACHIAN OIL FIELD FROM 1889 TO 1899, BY STATES.

The following table gives the production of the different States in the Appalachian field from 1889 to 1899, outside of the small production in Kentucky and Tennessee.

The difficulty in completely separating the New York and Pennsylvania production, owing to the Bradford pool continuing without interruption from one State to the other, has made it necessary to combine the totals for these two States.

Production of petroleum in the Appalachian oil field from 1889 to 1899.

[Barrels of 42 gallons.]

Year.	Pennsylvania and New York.	West Virginia.	Southeastern Ohio.	Total.
1889	21,487,435	544,113	318,277	22,349,825
1890	28,458,208	492,578	1,116,521	30,067,307
1891	33,009,236	2,406,218	424,323	35,839,777
1892	28,422,377	3,810,086	1,193,414	33,425,877
1893	20,314,513	8,445,412	2,602,965	31,362,890
1894	19,019,990	8,577,624	3,184,310	30,781,924
1895	19,144,390	8,120,125	3,694,624	30,959,139
1896	20,584,421	10,019,770	3,366,031	33,970,222
1897	19,262,066	13,090,045	2,877,838	35,229,949
1898	15,948,464	13,615,101	2,148,292	31,711,857
1899	14,374,512	13,910,630	4,764,934	33,050,076

From the above table it is shown that the increase in the Appalachian production in 1899 was 4.2 per cent over that of 1898, as compared with a decrease of 10 per cent in 1898 from that of 1897. Of the total production in 1899 Ohio furnished 14.4 per cent, West Virginia 42.1 per cent, and Pennsylvania and New York 43.5 per cent. In 1898 Ohio furnished 6.8 per cent, West Virginia 42.9, and Pennsylvania and New York 50.3. This table shows an increase in southeastern Ohio of 2,616,642 barrels, or 121.8 per cent, in 1899 over that of 1898.

PRODUCTION IN THE APPALACHIAN OIL FIELD, BY MONTHS.

In the following table is given the production of crude petroleum in the Appalachian oil field from 1894 to 1899, by months:

Production of crude petroleum in the Appalachian oil field from 1894 to 1899, by months.

[Barrels of 42 gallons.]

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	2,627,123	2,469,941	2,727,891	2,754,761	2,816,280	2,491,156
February	2,330,582	2,083,087	2,528,867	2,663,406	2,465,715	2,283,943
March	2,671,051	2,504,645	2,711,088	2,935,568	2,864,176	2,735,261
April	2,494,772	2,588,727	2,933,487	2,809,148	2,688,999	2,641,307
May	2,654,299	2,586,710	2,888,502	2,902,571	2,714,058	2,823,731
June	2,637,416	2,488,551	2,916,018	2,990,489	2,595,135	2,794,575
July	2,659,718	2,673,621	2,972,001	3,035,334	2,572,648	2,843,626
August	2,605,494	2,753,417	2,871,118	3,115,375	2,667,974	2,999,744
September	2,465,689	2,685,766	2,831,507	3,035,321	2,578,710	2,838,459
October	2,638,689	2,717,958	2,901,781	3,078,061	2,581,226	2,919,006
November	2,460,880	2,661,700	2,745,756	2,983,616	2,527,486	2,861,905
December	2,536,211	2,745,016	2,942,206	2,926,299	2,639,450	2,817,363
Total	30,781,924	30,959,139	33,970,222	35,229,949	31,711,857	33,050,076

PIPE-LINE RUNS IN THE APPALACHIAN FIELD.

Usually the terms "production" and "pipe-line runs" are considered as synonymous, but production is always slightly in excess of runs. The expression "pipe-line runs" means the amount of oil that the pipe lines have received from the wells, and as the pipe lines do not run all the oil in the tanks at the wells it would be remarkable if the same amount remained in the tanks at the wells at the close of each year. The true yearly runs would be obtained if there were the same amount on hand at the end of the year that there was at the beginning. If there were more, the difference should be subtracted from the total runs to get the total production. As there is some oil delivered to cars and to refineries that is not handled by the pipe lines, the total production will be more than the pipe-line runs. The production in the Appalachian field in 1899 was 33,050,076 barrels; the pipe-line runs 32,260,689 barrels, a difference of 789,387 barrels.

In the following table will be found the pipe-line runs in the Appalachian oil field in 1899, by lines and by months:

Pipe-line runs in the Appalachian oil field in 1899, by lines and months.

[Barrels of 42 gallons.]

Month.	National Transit.	Southwest.	Eureka.	Tide Water.	Producers and Refiners' Pipe Line Company, Limited.
January	544, 049	279, 917	1, 109, 384	126, 026	106, 086
February	489, 516	259, 990	980, 687	122, 945	98, 133
March	597, 955	312, 758	1, 113, 772	141, 387	113, 220
April	582, 108	294, 430	1, 071, 899	137, 872	107, 027
May	596, 430	315, 741	1, 168, 564	132, 958	108, 414
June	583, 348	302, 421	1, 156, 132	130, 459	113, 174
July	578, 397	299, 209	1, 163, 771	124, 039	112, 880
August	603, 007	317, 410	1, 205, 578	129, 040	110, 596
September	576, 733	309, 478	1, 164, 707	124, 126	112, 748
October	590, 739	310, 908	1, 203, 102	124, 204	114, 047
November	561, 193	303, 833	1, 219, 957	139, 672	110, 422
December	531, 787	314, 216	1, 208, 208	132, 883	106, 689
Total	6, 835, 262	3, 620, 311	13, 765, 761	1, 565, 611	1, 313, 436

Pipe-line runs in the Appalachian oil field in 1899, by lines and months—Continued.

[Barrels of 42 gallons.]

Month.	Elk.	Emery.	Franklin.	Buckeye-Macksburg.	Total.
January	16, 470	23, 773	2, 756	214, 365	2, 422, 826
February	13, 803	21, 450	4, 203	236, 365	2, 227, 092
March	16, 273	26, 931	5, 841	327, 232	2, 655, 369
April	15, 580	24, 583	4, 197	384, 750	2, 622, 446
May	15, 863	24, 416	6, 264	403, 361	2, 772, 011
June	15, 504	25, 493	4, 659	414, 366	2, 745, 556
July	15, 310	25, 389	4, 569	457, 512	2, 781, 076
August	14, 998	24, 289	3, 930	467, 196	2, 876, 044
September	15, 076	23, 619	4, 682	438, 444	2, 769, 613
October	14, 166	25, 416	3, 983	450, 826	2, 837, 391
November	15, 574	24, 010	4, 838	431, 723	2, 811, 222
December	16, 697	23, 581	3, 356	402, 626	2, 740, 043
Total	185, 314	292, 950	53, 278	4, 628, 766	32, 260, 689

Pipe-line runs in the Appalachian oil field from 1888 to 1899, inclusive.

[Barrels of 42 gallons.]

Year.	National Transit.	Tide Water.	Octave.	Pittsburg.	Southwest.	Franklin.
1888	11, 503, 084	1, 389, 599	25, 072	344, 618	1, 845, 076	76, 512
1889	13, 675, 776	1, 593, 939	32, 536	....	3, 734, 519	64, 244
1890	15, 407, 552	1, 827, 798	36, 001	....	7, 565, 743	67, 788
1891	14, 046, 171	1, 777, 875	36, 527	....	13, 317, 894	65, 185
1892	11, 362, 978	1, 458, 462	30, 137	....	10, 829, 246	58, 459
1893	8, 037, 337	1, 579, 586	23, 348	....	5, 740, 856	66, 278
1894	8, 248, 016	1, 751, 897	10, 699	....	5, 540, 345	57, 070
1895	8, 863, 706	1, 803, 636	....	....	5, 253, 378	48, 711
1896	9, 476, 112	1, 993, 449	....	....	6, 666, 334	49, 329
1897	9, 807, 620	1, 822, 480	....	....	5, 329, 358	48, 880
1898	7, 943, 222	1, 561, 458	....	....	4, 133, 458	56, 090
1899	6, 835, 262	1, 565, 611	....	....	3, 620, 311	53, 278

Pipe-line runs in the Appalachian oil field from 1888 to 1899, inclusive—Continued.

[Barrels of 42 gallons.]

Year.	Western and Atlantic.	Charles Miller.	Producers' Pipe Line.	Eureka.	Elk.
1888	842,890	99,525			
1889	2,501,826	188,113			
1890	3,109,477	160,571			
1891	2,173,213	143,700		2,184,413	257,995
1892	1,442,160	68,888		3,666,066	324,219
1893	1,019,849	36,724	39,214	7,554,866	280,870
1894	68,117			7,774,215	218,874
1895				7,313,251	243,839
1896				9,983,201	283,741
1897				13,008,941	227,817
1898				13,558,409	194,229
1899				13,765,761	185,314

Year.	Emery.	Mellon.	Producers and Refiners' Pipe Line Company, Limited.	Buckeye-Macksburg.	Total.
1888				240,288	16,366,664
1889				238,776	22,029,729
1890				1,021,613	21,196,543
1891	155,976	340,085		377,232	34,876,266
1892	329,458	1,813,263	249,079	1,117,147	32,749,562
1893	371,058	3,103,915	1,074,244	2,075,115	31,003,260
1894	359,459	2,528,852	1,196,849	2,362,703	30,117,096
1895	330,663	1,985,376	1,554,376	2,954,478	30,351,414
1896	322,685		1,392,170	3,338,176	33,505,197
1897	318,074		1,316,460	2,893,935	34,773,565
1898	311,308		1,260,204	2,138,071	31,156,449
1899	292,950		1,313,436	4,628,766	32,260,689

The above table is conspicuous in showing an increase of 116 per cent in the Buckeye-Macksburg Pipe Line. This is owing to the production in the Scio field, which came into prominence early in 1899.

AVERAGE DAILY PRODUCTION OF THE APPALACHIAN OIL FIELD FROM 1893 TO 1899, INCLUSIVE, BY MONTHS AND YEARS.

The average daily production, which follows closely the pipe-line runs reported daily in all the oil exchanges, is generally accepted by the producer and refiner as the standard by which comparisons are

made. The amounts are obtained by dividing the monthly production by the number of days in each particular month. The average yearly production is secured by dividing the total by 365 or 366, as the case may be.

Average daily production of crude petroleum in the Appalachian oil field each month, for the years 1893 to 1899, by months and years.

[Barrels.]

Month.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	80,382	84,746	79,676	87,996	88,863	90,848	80,373
February	83,946	83,235	74,396	87,202	95,122	88,061	81,569
March	89,339	86,163	80,795	87,454	94,695	92,392	88,234
April	83,120	83,159	86,291	97,783	93,638	89,633	88,043
May	86,247	85,622	83,443	93,177	93,631	87,550	91,088
June	88,970	87,914	82,952	97,201	99,683	86,504	93,153
July	85,746	85,797	86,246	95,871	97,914	82,988	91,730
August	88,947	84,048	88,820	92,617	100,496	86,064	96,766
September	89,410	82,190	89,526	94,384	101,177	85,957	94,615
October	85,535	85,119	87,676	93,606	99,292	83,265	94,161
November	83,776	82,030	88,723	91,525	99,454	84,249	95,397
December	85,550	81,813	88,549	94,910	94,397	85,143	90,883
Average	85,926	84,334	84,820	92,815	96,520	86,882	90,548

The above table includes some oil not handled by the pipe lines, owing to its proximity to refineries, to which it is hauled or delivered by private lines. The increase in 1899 was 4.2 per cent as compared with 1898.

SHIPMENTS OF PETROLEUM FROM THE APPALACHIAN FIELD.

The following table gives the total deliveries of petroleum by pipe lines from 1892 to 1899, inclusive, by years and months. These figures represent the quantity of petroleum delivered out of their receiving tanks to customers during 1899, amounting to 30,317,426 barrels, which was 88,510 barrels less than the quantity delivered in 1898.

The pipe-line companies always receive more oil than is shown by deducting shipments from runs. The pipe-line runs for 1899 were 32,260,689 barrels; shipments for the same year were 30,317,426 barrels, which would leave 1,943,263 to go to the credit of stocks, and if added to the stocks on hand at the end of 1898 would amount to 13,729,569 barrels, instead of 13,451,191 barrels. This excess is absorbed by sand, paraffin, scale, and water, forming what is known as B. S., and which is unsalable.

Total shipments of petroleum in the Appalachian oil fields from 1892 to 1899, by months.

[Barrels of 42 gallons.]

Month.	1892.	1893.	1894.	1895.
January	2, 420, 825	2, 957, 358	3, 141, 722	3, 140, 864
February	2, 443, 546	2, 584, 742	2, 656, 026	2, 808, 801
March	2, 586, 075	2, 843, 938	2, 912, 594	2, 608, 232
April	2, 338, 421	2, 666, 199	2, 846, 805	2, 781, 379
May	2, 278, 027	3, 033, 700	2, 819, 413	2, 845, 334
June	2, 108, 386	3, 074, 443	2, 914, 400	2, 816, 698
July	2, 314, 405	3, 319, 658	2, 927, 036	2, 634, 880
August	2, 626, 043	3, 248, 873	3, 256, 397	2, 424, 843
September	2, 770, 472	3, 000, 740	2, 966, 864	2, 332, 271
October	2, 824, 508	3, 316, 914	3, 271, 371	2, 573, 915
November	2, 916, 265	3, 096, 578	3, 208, 560	2, 655, 325
December	2, 978, 921	3, 152, 238	3, 286, 087	2, 410, 084
Average	2, 550, 491	3, 024, 615	3, 017, 273	2, 669, 386
Total	30, 605, 894	36, 295, 381	36, 207, 275	32, 032, 626

Month.	1896.	1897.	1898.	1899.
January	2, 543, 518	2, 538, 501	2, 909, 176	2, 484, 546
February	2, 252, 417	2, 311, 488	2, 133, 424	1, 905, 583
March	2, 438, 900	2, 773, 710	2, 627, 845	2, 635, 454
April	2, 227, 514	2, 454, 018	2, 422, 105	2, 379, 122
May	2, 418, 590	2, 546, 696	2, 393, 831	2, 579, 304
June	2, 249, 062	2, 556, 161	2, 435, 248	2, 538, 921
July	2, 540, 332	2, 707, 317	2, 563, 825	2, 357, 716
August	2, 404, 298	3, 100, 209	2, 696, 018	2, 779, 825
September	2, 542, 963	2, 956, 036	2, 585, 253	2, 704, 392
October	2, 606, 494	3, 638, 301	2, 847, 108	2, 743, 677
November	2, 502, 035	3, 320, 084	2, 408, 127	2, 607, 901
December	2, 614, 072	2, 761, 803	2, 383, 976	2, 600, 985
Average	2, 445, 016	2, 805, 360	2, 533, 828	2, 526, 452
Total	29, 340, 195	33, 664, 324	30, 405, 936	30, 317, 426

STOCKS OF PETROLEUM IN THE APPALACHIAN OIL FIELD.

In the following table will be found a statement of the stocks of petroleum in the tanks of the pipe-line companies in the Appalachian oil field at the close of each month from 1892 to 1899:

Total stocks of petroleum in the Appalachian oil field at the close of each month from 1892 to 1899.

[Barrels of 42 gallons.]

Month.	1892.	1893.	1894.	1895.
January	16,973,225	17,305,206	11,755,219	5,859,348
February	17,416,399	17,042,245	11,384,776	5,087,498
March	17,587,512	16,834,533	11,295,959	4,942,643
April	18,028,753	16,641,773	10,751,983	4,730,819
May	18,464,378	16,285,855	10,639,454	4,506,874
June	19,056,902	15,845,548	10,381,209	4,275,506
July	19,446,441	15,182,551	9,869,915	4,306,287
August	19,563,635	14,730,600	9,210,959	4,592,906
September	19,394,242	14,261,432	8,730,456	4,908,593
October	19,039,149	13,559,543	8,038,376	5,013,941
November	18,529,914	12,904,344	7,283,988	4,988,092
December	18,037,385	12,316,611	6,499,880	5,344,784
Average	18,461,495	15,242,520	9,653,515	4,879,775

Month.	1896.	1897.	1898.	1899.
January	5,499,477	9,904,200	10,851,673	11,722,555
February	5,741,797	10,308,262	11,170,947	12,034,804
March	6,005,732	10,426,110	11,370,864	12,054,356
April	6,697,481	10,772,213	11,611,688	12,301,840
May	7,153,922	11,088,493	11,909,904	12,497,709
June	7,791,359	11,485,001	12,052,282	12,702,241
July	8,182,582	11,830,322	11,976,516	13,067,316
August	8,672,385	11,794,707	11,908,617	13,155,777
September	8,924,639	11,872,575	11,852,553	13,150,046
October	9,178,509	11,246,836	11,490,444	13,199,969
November	9,409,098	10,870,883	11,572,734	13,365,565
December	9,745,722	11,010,044	11,786,603	13,451,191
Average	7,750,225	11,050,804	11,629,569	12,725,281

The foregoing table shows an increase in the amount of crude petroleum stored in the tanks of the pipe-line companies. At the close of 1899 the stocks were 13,451,191 barrels, as compared with 11,786,603 barrels, December 31, 1898, a gain of 1,664,588 barrels. It is upon this petroleum in stock as security that the pipe-line certificates are issued. This they must protect by the purchase of fresh petroleum, if necessary, to make good the loss by evaporation, and by the settlings of paraffin, sand and water, known as "B. S.," which is unsalable for refining purposes. The pipe-line company must also make good by purchase any loss by fire, flood, bursting of tanks, lines, etc.

Shipments are added or subtracted from stocks, as the case may be, according as they are less or greater than the runs, and petroleum is purchased by the pipe-line company to make good any losses or shortage, but the purchased petroleum does not appear on the statement as runs. Outside of the storage tanks of the pipe-line company there is a large amount of petroleum stored in large and small tanks at the wells of the producing companies which does not appear in any statement.

PRICES OF CRUDE PETROLEUM IN THE APPALACHIAN OIL FIELD.

The prices of crude petroleum in the Appalachian oil field, as arranged in the following table, show the monthly and yearly average price of pipe-line certificates or the price of crude petroleum at the primary markets from 1860 to 1899. In the early history of the industry covered by the table, before the introduction of pipe lines, the prices quoted usually meant the price at the wells or at some point not far distant. In late years the price given is that of pipe-line certificates, which are issued to holders of a thousand barrels of oil in any of the districts; or a producer or owner may "bunch" his production in the different districts to secure the issuing of a 1,000-barrel certificate as soon as it has been run into the tanks of the pipe-line company. These certificates are made payable to bearer and are therefore transferable; they are subject to a transportation charge in the district of 20 cents per barrel and a charge for storage at the rate of 25 cents per day per 1,000 barrels when the price is less than \$1, 30 cents when over \$1 and less than \$1.50, and 40 cents for all over \$1.50 per barrel. They are to be returned for exchange to the pipe-line company within six months after issue, or be subject to a charge of one-twentieth of 1 per cent daily thereafter until exchanged. To cover losses by fire or lightning certificates are subject to an assessment pro rata on all oil in the custody of the pipe line. None of these charges are included in the prices of petroleum as quoted, and therefore the prices given are the prices at or near the wells.

The average prices cover the ordinary grades of oil. They do not include special oils, such as that from the Franklin lubricating district

or that of Petroleum and Volcano of West Virginia, nor the Mecca-Belden district of Ohio, but only such oil as Pennsylvania oil and used chiefly for the production of illuminants. It is also true that in some of the districts oil is worth more than ordinary Pennsylvania oil and in some districts it is worth less. This is owing to the fact that some districts produce oil that furnishes a larger percentage of illuminating oil and a larger percentage of by-products. Petroleum that has remained in tanks at the wells for a long period loses a percentage of its illuminating properties, and is worth less than what is known as fresh oil or petroleum recently produced at the wells.

These averages, it should be understood, are not the true averages—that is, averages that consider the price and the quantity sold at that price—but they are the averages of the prices obtained for certificates or for oil at the primary markets from day to day. It is probable that the true average prices would be slightly under the averages obtained by averaging the prices. The figures given in the following tables are, under these conditions, the only ones that can be ascertained, and do not vary much from the true average:

Monthly and yearly average prices of pipe-line certificates of Pennsylvania crude petroleum at wells from 1860 to 1899.

[Per barrel of 42 gallons.]

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
1860	$19.25	$18.00	$12.62½	$11.00	$10.00	$9.50	$8.62½	$7.50	$6.62½	$5.50	$3.75	$2.75	$9.59
1861	1.00	1.00	1.00	.62½	.50	.50	.50	.25	.20	.10	.10	.10	.49
1862	.10	.15	.22½	.50	.85	1.00	1.25	1.25	1.25	1.75	2.00	2.25	1.05
1863	2.25	2.50	2.62½	2.87½	2.87½	3.00	3.25	3.37½	3.50	3.75	3.85	3.95	3.15
1864	4.00	4.37½	5.50	6.56	6.87½	9.50	12.12½	10.12½	8.87½	7.75	10.00	11.00	8.06
1865	8.25	7.50	6.00	6.00	7.37½	5.62½	5.12½	4.62½	6.75	8.12½	7.25	6.50	6.59
1866	4.50	4.40	3.75	3.95	4.50	3.87½	3.00	3.75	4.50	3.39	3.10	2.12½	3.74
1867	1.87½	1.85	1.75	2.07½	2.35	1.90	2.62½	3.15	3.40	3.55	2.50	1.87½	2.41
1868	1.95	2.00	2.55	2.82⅛	3.75	4.50	5.12½	4.57½	4.00	4.12½	3.75	4.35	3.62½
1869	5.75	6.95	6.00	5.70	5.35	4.95	5.37½	5.57½	5.50	5.50	5.80	5.12½	5.63¾
1870	4.52½	4.52½	4.45	4.22½	4.40	4.17½	3.77½	3.15	3.25	3.27½	3.22½	3.40	3.86
1871	3.82½	4.38	4.25	4.01	4.60	3.85½	4.79	4.66	4.65	4.82½	4.25	4.00	4.34
1872	4.02½	3.80	3.72½	3.52½	3.80	3.85	3.80	3.58½	3.25	3.15	3.83½	3.32½	3.64
1873	2.60	2.20	2.12½	2.30	2.47½	2.22½	2.00	1.42½	1.15	1.20	1.25	1.00	1.83
1874	1.20	1.40	1.60	1.90	1.62½	1.32½	1.02½	.95	.95	.85	.55	.61½	1.17
1875	1.03	1.52½	1.75	1.36½	1.40	1.26½	1.09	1.13	1.33	1.32½	1.44	1.55	1.35
1876	1.80	2.60	2.01	2.02½	1.90½	2.01¾	2.24¼	2.71⅜	3.81	3.37½	3.11	3.73	2.56¼
1877	3.53¼	2.70	2.67½	2.58	2.24	1.94⅝	2.07½	2.51	2.38	2.56¾	1.91	1.80	2.42
1878	1.43	1.65¼	1.59	1.37½	1.35¼	1.14	.98¾	1.01	.86⅝	.82½	.89⅜	1.16	1.19
1879	1.03	.98	.86¼	.78½	.76	.68⅜	.69⅞	.67⅛	.69⅜	.88⅛	1.05⅝	1.18⅓	.85⅞
1880	1.10¼	1.03⅛	.88¾	.78	.80	1.00	1.06¼	.91	.96	.96⅞	.91⅛	.91⅝	.94½

1881......	.95½	.90⅜	.83⅜	.86¼	.81⅞	.81¼	.76⅞	.78⅛	.97⅛	.91¼	.85¼	.84⅜	.85⅞
1882......	.83⅛	.84½	.81⅜	.78⅜	.71½	.54⅜	.57⅜	.58⅝	.72⅛	.93¾	1.14	.96	.78⅛
1883......	.93¾	1.01	.97⅝	.94⅜	1.00⅛	1.16⅜	1.05⅞	1.08	1.12½	1.11⅛	1.14½	1.14¾	1.05¾
1884......	1.11	1.04⅜	.98⅛	.94	.85⅝	.68⅝	.63½	.81⅞	.78	.71⅛	.72½	.74⅜	.83½
1885......	.70⅞	.72⅜	.80⅜	.78½	.79	.82	.92½	1.00¼	1.00¾	1.05½	1.04⅜	.89⅝	.87⅞
1886......	.88⅝	.79⅞	.77¼	.74⅛	.70	.66½	.66	.62⅛	.63⅜	.65⅛	.71⅝	.70⅝	.71¼
1887......	.70	.64⅝	.63⅜	.64⅞	.64⅛	.62⅝	.59¼	.60⅛	.67	.70⅞	.73⅞	.80¾	.66¾
1888......	.91¼	.91⅝	.98⅝	.82⅝	.86¾	.75⅞	.80⅝	.90⅛	.93⅝	.90⅝	.85⅜	.89¼	.87⅝
1889......	.86⅝	.89¼	.90⅞	.88	.83⅛	.83⅞	.95⅛	.99½	.99⅛	1.01⅜	1.08½	1.04⅛	.94⅛
1890......	1.05¾	1.05⅝	.90	.82⅝	.88⅞	.89¼	.89⅛	.89¼	.81⅞	.80⅛	.72⅜	.67¼	.86¾
1891......	.74¼	.78⅜	.74¼	.71½	.69¾	.68⅛	.66½	.64	.58½	.60½	.58¾	.59⅝	.67
1892......	.62⅜	.60¼	.57⅛	.57⅞	.57⅜	.54⅛	.52½	.55	.54⅜	.51⅜	.52	.53¼	.55⅝
1893......	.53½	.57⅜	.65¼	.68¾	.58¾	.60¼	.57⅝	.58⅞	.64⅝	.70¾	.73⅞	.78¼	.64
1894......	.79¾	.80⅝	.82	.84¼	.86	.89⅜	.83⅛	.81	.83	.83	.83	.91½	.83⅞
1895......	.99	1.04⅜	1.09¾	1.79	1.74¼	1.53⅝	1.46⅝	1.26⅛	1.22⅜	1.24¼	1.48⅜	1.42	1.35⅞
1896......	1.42⅝	1.36⅝	1.28½	1.22½	1.15⅜	1.14¾	1.08¼	1.05	1.12	1.15	1.16	.98	1.17⅞
1897......	.88	.90⅛	.92⅛	.85⅞	.86¾	.86¼	.76¾	.71	.69¾	.67⅜	.65	.65	.78⅝
1898......	.65	.67¾	.78⅝	.73¾	.82¼	.87⅛	.93¼	.97⅝	1.01¾	1.13⅛	1.16⅜	1.17½	.91⅛
1899......	1.17	1.15	1.13	1.13	1.13	1.13¼	1.22⅜	1.27½	1.44½	1.50⅞	1.57⅜	1.65⅛	1.29⅜

The preceding table shows the average price for each month and year from 1860 to 1899. The average price during 1899 showed a gain of 38¼ cents over 1898, and was only 6½ cents lower than the average for 1895, which was the highest price paid for petroleum since 1877.

For a number of years the prices of certificate oil, that term meaning the oil taken as standard and merchantable by the pipe lines, ruled the market or selling price of crude petroleum. These certificates were bought and sold on the floor of the oil exchanges. In past years there was a large amount of oil held as stocks, and as these were depleted it was necessary for the pipe-line companies to recall a large number of these certificates. As the stocks were reduced it came to pass that a comparatively small amount of oil would control the entire trade. On January 23, 1895, the following notice was posted at the various offices of what is known as the Seep Purchasing Agency, Mr. Joseph Seep being the purchaser for the refineries of the Standard Oil Company:

"From this date the prices quoted are not those of certificate oil, but the prices paid by the Seep Purchasing Agency."

There was at times considerable difference in the prices paid for certificates and that paid by the Seep agency, as shown by the quotations at the Oil City Exchange.

To enable anyone wishing to dispose of 1,000 barrels of oil in the tanks of the pipe lines at the price paid by the oil exchange, the Seep agency will negotiate the sale free of charge for the party having the oil in the line and will pay the average price upon which sales were made in the exchange on that day.

In the following table is given the range of prices paid producers in the Pennsylvania region in 1899. Prices are given for those dates in which changes were made. The great volume of trade is controlled by the prices under Pennsylvania, which includes all the oil sold in New York, nearly all of that sold in Pennsylvania and West Virginia, and a large proportion of the ordinary Appalachian petroleum sold in Ohio:

Range of prices paid for petroleum in the Appalachian oil regions by the Seep Purchasing Agency in 1899.

Date.	Pennsylvania.	Tiona.	Corning.	Newcastle.	Barnesville.
January 1	$1.19	$1.29	$1.02	$0.94	$1.09
January 12	1.17	1.27	1.00	.92	1.07
January 13	1.16	1.26	.99	.91	1.06
January 30	1.15	1.25	.98	.90	1.05
February 28	1.13	1.23	.96	.88	1.03
March 16	1.13	1.28	.96	.88	1.03
June 28	1.15	1.30	.98	.90	1.05
June 30	1.17	1.32	1.00	.92	1.07
July 6	1.19	1.34	1.02	.94	1.09
July 11	1.21	1.36	1.04	.96	1.11
July 14	1.23	1.38	1.06	.98	1.13
July 18	1.25	1.40	1.08	1.00	1.15
July 31	1.27	1.42	1.10	1.02	1.17
August 29	1.30	1.45	1.13	1.05	1.20
August 31	1.35	1.50	1.18	1.10	1.25
September 2	1.37	1.52	1.20	1.12	1.27
September 5	1.40	1.55	1.23	1.15	1.30
September 12	1.43	1.58	1.26	1.18	1.33
September 14	1.45	1.60	1.28	1.20	1.35
September 20	1.48	1.63	1.31	1.23	1.38
September 26	1.50	1.65	1.33	1.25	1.40
October 23	1.53	1.68	1.36	1.28	1.43
November 1	1.56	1.71	1.39	1.31	1.46
November 20	1.58	1.73	1.41	1.33	1.48
November 24	1.61	1.76	1.44	1.36	1.51
December 6	1.64	1.79	1.47	1.39	1.54
December 7	1.66	1.81	1.49	1.41	1.56

Almost the entire output of the Appalachian field is sold under the head of Pennsylvania oil or petroleum. The average price in 1899 was $1.29⅝. The output of the Tiona field was only 212,217 barrels. The average price was $1.43¼ per barrel. The combined output of the Barnesville, Corning, and Newcastle fields was sold on an average of 20 cents less than Pennsylvania petroleum.

In the following tables are given the average monthly prices, during 1898 and 1899, of crude petroleum produced in the various districts of the Appalachian oil regions in which special prices are paid:

Average monthly prices of Appalachian crude petroleum, per barrel of 42 gallons, in 1898.

Month.	Tiona.	Pennsylvania.	Barnesville.	Corning.	Newcastle.
January	\$0.75	\$0.65	\$0.55	\$0.48	\$0.40
February	.77¾	.67¾	.57¾	.50¾	.42¾
March	.88⅝	.78⅝	.68⅝	.61⅝	.53⅝
April	.83¾	.73¾	.63¾	.56¾	.48¾
May	.92¼	.82¼	.72¼	.65¼	.57¼
June	.97⅛	.87⅛	.77⅛	.70⅛	.62⅛
July	1.03¼	.93¼	.83¼	.76¼	.68¼
August	1.07⅝	.97⅝	.87⅝	.80⅝	.72⅝
September	1.11¾	1.01¾	.91¾	.84¾	.76¾
October	1.23⅛	1.13⅛	1.03⅛	.96⅛	.88⅛
November	1.26⅜	1.16⅜	1.06⅜	.99⅜	.91⅜
December	1.27½	1.17½	1.07½	1.00½	.92½
Average	1.01⅛	.91⅛	.81⅛	.74⅛	.66⅛

Average monthly prices of Appalachian crude petroleum, per barrel of 42 gallons, in 1899.

Month.	Tiona.	Pennsylvania.	Barnesville.	Corning.	Newcastle.
January	\$1.27	\$1.17	\$1.07	\$1.00	\$0.92
February	1.25	1.15	1.05	.98	.90
March	1.25⅝	1.13	1.03	.96	.88
April	1.28	1.13	1.03	.96	.88
May	1.28	1.13	1.03	.96	.88
June	1.28¼	1.13¼	1.03¼	.96¼	.88¼
July	1.37⅜	1.22⅜	1.12⅜	1.05⅜	.97⅜
August	1.42½	1.27½	1.17½	1.10½	1.02½
September	1.59½	1.44½	1.34½	1.27½	1.19½
October	1.65⅞	1.50⅞	1.40⅞	1.33⅞	1.25⅞
November	1.72⅜	1.57⅜	1.47⅜	1.40⅜	1.32⅜
December	1.80⅛	1.65⅛	1.55⅛	1.48⅛	1.40⅛
Average	1.43¼	1.29⅜	1.19⅜	1.12⅜	1.04⅜

The following table, taken from the Derrick's Handbook, gives the highest and lowest prices of Pennsylvania crude petroleum for every year since 1859. The months during which the highest and lowest prices were attained are likewise shown:

Highest and lowest prices of Pennsylvania crude petroleum each year since 1859.

Year.	Highest month.	Price.	Lowest month.	Price.
1859	September	$20.00	December	$20.00
1860	January	20.00	December	2.00
1861	January	1.75	December	.10
1862	December	2.50	January	.10
1863	December	4.00	January	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	January	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	January	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.82½
1874	February	2.25	November	.62½
1875	February	1.82½	January	.75
1876	December	4.23¾	January	1.47½
1877	January	3.69⅜	June	1.53¾
1878	February	1.87½	September	.78¾
1879	December	1.28¾	June	.63⅛
1880	June	1.24⅜	April	.71¼
1881	September	1.01¼	July	.72½
1882	November	1.37	July	.49¼
1883	June	1.24¾	January	.83¼
1884	January	1.15⅝	June	.51¼
1885	October	1.12⅝	January	.68
1886	January	.92¼	August	.59¾
1887	December	.90	July	.54
1888	March	1.00	June	.71⅜
1889	November	1.12½	April	.79½
1890	January	1.07⅝	December	.60¾
1891	February	.81⅜	August	.50
1892	January	.64⅛	October	.50
1893	December	.80	January	.52⅞
1894	December	.95¾	January	.78½
1895	April	2.60	January	.95¼
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	December	1.66	February	1.13

WELL RECORDS IN THE APPALACHIAN OIL FIELD.

The following table shows the total number of wells completed each month in the several districts for 1899:

Total number of wells completed in the Appalachian oil field in 1899, by months and districts.

Month.	Bradford.	Allegany.	Middle.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Southeastern Ohio.	Total.
January	50	38	29	95	54	233	84	583
February	17	24	20	56	45	169	123	454
March	48	46	24	85	47	210	166	626
April	38	46	27	95	49	190	171	616
May	62	65	45	134	58	220	167	751
June	76	64	65	139	56	228	181	809
July	57	44	42	137	61	240	170	751
August	62	52	53	139	56	255	148	765
September	54	52	59	153	72	271	142	803
October	72	56	50	172	69	312	155	886
November	56	50	80	180	72	314	143	895
December	50	60	64	150	60	283	146	813
Total	642	597	558	1,535	699	2,925	1,796	8,752

The number of wells drilled in 1899, as shown in the above table, exceeds that of any year in the history of the oil trade. There was an increase of 3,960, amounting to 83 per cent over 1898. Of the 8,752 wells drilled in 1899, 1,920 of them did not furnish oil in paying quantities and were classified as dry. The producing wells drilled in 1899 were, therefore, 6,832, or 72 per cent of the total, while 28 per cent were dry as compared with 26½ per cent that were dry in 1898. This is rather surprising when the large number of wells drilled in 1899 is considered. The wells drilled in the Franklin lubricating petroleum district in Pennsylvania and the Volcano and Burning Springs lubricating petroleum districts are not included in the above table.

Total number of wells completed in the Appalachian oil field from 1891 to 1899.

District.	Wells completed.								
	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Bradford	278	37	52	284	578	769	696	488	642
Allegany	91	21	41	82	258	331	350	264	597
Middle	331	131	91	215	401	594	481	388	558
Venango and Clarion	650	131	243	731	1,783	1,614	990	772	1,535
Butler and Armstrong	597	342	298	755	1,292	1,153	802	497	699
Southwest	1,414	1,230	1,065	1,481	2,364	2,744	2,255	2,017	2,925
Southeastern Ohio	27	76	190	215	460	619	498	366	1,796
Total	3,388	1,968	1,980	3,763	7,136	7,824	6,072	4,792	8,752

The above table indicates a large gain in the wells drilled in all of the fields, but notably so in southeastern Ohio, which last is due to the sudden development of the Scio field. In this division there were five wells drilled in 1899 to one in 1898.

The following table gives the number of wells drilled in the Appalachian oil field from 1891 to 1899, inclusive, by months. It will be noticed that the greatest number of wells are usually completed in June, July, August, and September, in which months there is generally the largest production.

Number of wells completed in the Appalachian oil field each month from 1891 to 1899, by months and years.

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	310	182	135	189	296	580	599	327	583
February	243	180	99	176	212	555	438	255	454
March	275	149	143	217	355	542	414	274	626
April	288	174	146	278	462	614	486	329	616
May	314	174	196	324	658	729	548	330	751
June	304	162	228	370	810	793	604	364	809
July	334	179	219	342	822	739	638	390	751
August	333	143	163	359	814	640	601	417	765
September	281	146	179	381	775	644	489	475	803
October	246	160	154	394	727	624	446	530	886
November	255	174	144	390	638	682	426	532	895
December	205	145	174	343	567	682	383	569	813
Total	3,388	1,968	1,980	3,763	7,136	7,824	6,072	4,792	8,752

Initial daily production of new wells in the Appalachian oil field from 1891 to 1899, by districts.

[Barrels of 42 gallons.]

District.	1891.	1892.	1893.	1894.
Bradford	1,596	152	410	2,296
Allegany	481	77	100	326
Middle	2,509	486	744	1,953
Venango and Clarion	3,736	534	1,533	3,815
Butler and Armstrong	18,178	10,668	6,345	16,592
Southwest	155,853	89,568	76,633	64,364
Southeastern Ohio	371	1,768	2,610	2,698
Total	182,724	103,253	88,375	92,044
Average of all districts	26,103	14,750	12,625	13,149

District.	1895.	1896.	1897.	1898.	1899.
Bradford	3,431	9,462	7,037	5,354	4,089
Allegany	1,277	1,742	1,332	738	2,495
Middle	2,691	5,968	11,695	2,940	2,229
Venango and Clarion	6,511	5,652	3,311	2,126	4,045
Butler and Armstrong	18,073	13,725	6,940	2,131	3,730
Southwest	65,684	74,081	99,095	72,362	73,887
Southeastern Ohio	5,336	5,768	3,663	4,067	31,418
Total	103,003	116,398	133,073	89,718	121,893
Average of all districts	14,715	16,628	19,010	12,817	17,413

Average daily production of new wells in the Appalachian oil field from 1891 to 1899, by districts.

[Barrels of 42 gallons.]

District.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Bradford	6.1	5.6	8.0	8.0	6.8	13.7	12.09	12.60	7.56
Allegany	5.8	5.1	2.2	4.0	5.8	6.1	4.45	3.48	5.40
Middle	8.4	5.0	8.2	9.0	7.8	12.2	32.58	10.00	4.90
Venango and Clarion	6.9	5.8	6.3	5.2	4.3	4.2	4.00	3.34	3.07
Butler and Armstrong	37.9	43.0	21.3	22.0	19.3	17.0	13.69	7.30	7.80
Southwest	148.3	90.7	72.0	43.5	38.4	39.4	61.36	49.63	34.06
Southeastern Ohio	28.5	42.1	13.7	12.5	15.9	13.8	12.13	19.74	22.39

In the following table is given the initial daily production of new wells in the Appalachian field in 1899, by districts and months. By initial daily production is meant the production of the well when first drilled into the sand, so as to fully open up the pay streak, and this, in nearly all cases, is the maximum production. These figures do not include any of the production in the lubricating-oil districts of Pennsylvania or West Virginia.

Initial daily production of new wells in the Appalachian oil field in 1899, by months and districts.

[Barrels of 42 gallons.]

Month.	Bradford.	Allegany.	Middle.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Southeastern Ohio.	Total.
January	308	104	86	267	180	6,492	2,196	9,633
February	80	40	82	150	305	4,496	4,323	9,476
March	234	171	114	205	113	4,466	4,219	9,522
April	205	264	127	256	248	4,511	3,576	9,187
May	355	324	175	297	331	6,541	3,216	11,239
June	558	408	247	367	385	6,806	2,085	10,856
July	373	222	205	376	636	6,198	2,547	10,557
August	416	210	212	367	284	6,579	2,575	10,643
September	377	165	268	484	328	6,285	1,775	9,682
October	516	190	195	424	279	8,378	1,850	11,832
November	327	199	308	438	373	7,303	1,724	10,672
December	340	198	210	414	268	5,832	1,332	8,594
Average	341	208	186	337	311	6,157	2,618	10,158

The average initial daily production of the 6,832 new producing wells in 1899 was 13.14 barrels, as compared with an average of 25.6 barrels per well in 1898 and 29.6 per well in 1897.

Total initial daily production of new wells in the Appalachian oil field from 1891 to 1899, by months.

[Barrels of 42 gallons.]

Month.	1891.	1892.	1893.	1894.
January	13, 364	12, 249	5, 910	8, 667
February	6, 618	9, 992	6, 982	5, 914
March	7, 751	8, 661	7, 650	6, 100
April	7, 710	6, 751	6, 962	7, 584
May	7, 875	7, 793	8, 176	7, 430
June	5, 263	9, 585	10, 815	11, 443
July	6, 543	10, 669	7, 662	9, 009
August	13, 536	7, 861	8, 733	7, 691
September	18, 118	6, 347	6, 640	6, 912
October	46, 748	8, 833	4, 510	7, 838
November	33, 660	6, 932	6, 495	7, 507
December	15, 538	7, 580	7, 840	5, 949
Average	15, 227	8, 604	7, 365	7, 670

Month.	1895.	1896.	1897.	1898.	1899.
January	5, 938	7, 383	9, 289	9, 259	9, 633
February	3, 662	7, 829	8, 492	5, 247	9, 476
March	6, 150	8, 842	6, 048	7, 363	9, 522
April	6, 388	11, 253	8, 078	6, 555	9, 187
May	7, 859	11, 350	9, 471	7, 308	11, 239
June	9, 909	11, 825	13, 108	5, 709	10, 856
July	8, 786	10, 476	13, 834	5, 700	10, 557
August	12, 204	7, 471	16, 983	8, 380	10, 643
September	14, 728	8, 216	13, 350	8, 922	9, 682
October	9, 916	9, 263	13, 029	7, 671	11, 832
November	10, 374	10, 294	11, 502	8, 920	10, 672
December	7, 089	12, 196	9, 889	8, 684	8, 594
Average	8, 584	9, 700	11, 089	7, 476	10, 158

In the following table the total number of dry holes are enumerated by months and districts. There were 51 per cent more dry holes drilled in 1899 than in 1898, as compared with a decrease of 20 per cent in 1898 compared with 1897.

Total number of dry holes drilled in the Appalachian oil field in 1899.

Month.	Bradford.	Allegany.	Middle.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Southeastern Ohio.	Total.
January	11	10	8	17	20	51	30	147
February	3	15	5	6	17	33	14	93
March	14	14	9	13	21	53	26	150
April	7	8	6	10	21	59	26	137
May	12	12	10	21	15	61	29	160
June	7	12	11	21	13	65	43	172
July	3	11	5	20	14	61	38	152
August	8	7	6	27	16	63	33	160
September	9	15	10	16	25	64	26	165
October	9	10	8	25	27	76	35	190
November	11	8	15	24	16	85	41	200
December	6	12	10	16	16	84	50	194
Total	100	134	103	216	221	755	391	1,920

The number of dry holes in the Appalachian field from 1891 to 1899 in the different districts are noted in the following table:

Number of dry holes drilled in the Appalachian oil field from 1891 to 1899.

District.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Bradford	18	10	8	46	76	78	114	63	100
Allegany	8	6	22	28	39	46	51	52	134
Middle	34	35	17	31	58	104	122	94	103
Venango and Clarion	110	40	56	124	283	261	162	136	216
Butler and Armstrong	117	94	88	204	354	347	295	205	221
Southwest	363	243	206	357	653	865	640	559	755
Southeastern Ohio	14	34	46	85	125	200	196	160	391
Total	664	462	443	875	1,588	1,901	1,580	1,269	1,920

In the following table will be found the statement of the number of dry holes drilled in each month from 1891 to 1899, inclusive:

Dry holes drilled in the Appalachian oil field from 1891 to 1899.

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	46	37	39	36	76	145	154	108	147
February	61	36	24	41	55	147	109	75	93
March	52	38	36	54	87	142	116	95	150
April	59	40	28	68	110	155	128	105	137
May	48	48	41	67	119	175	131	87	160
June	72	33	48	84	170	190	141	83	172
July	67	43	40	67	181	188	162	113	152
August	66	31	40	80	185	151	158	103	160
September	41	40	43	102	169	148	140	113	165
October	50	37	35	91	176	133	105	118	190
November	59	40	28	100	139	160	122	121	200
December	43	39	41	85	121	167	114	148	194
Total	664	462	443	875	1,588	1,901	1,580	1,269	1,920

The following table presents the total number of rigs or derricks being built at the close of each month in each district during 1899. The average for 1896 was 414; for 1897, 297; for 1898, 260, and for 1899, 404.

Rigs building in the Appalachian oil field in 1899.

Month.	Bradford.	Allegany.	Middle.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Southeastern Ohio.	Total.
January	26	29	15	57	43	128	88	386
February	44	29	15	49	47	149	84	417
March	44	37	20	52	33	112	69	367
April	46	31	20	58	33	98	70	356
May	38	37	25	52	42	113	86	393
June	50	26	20	40	36	96	69	337
July	43	34	17	36	40	110	72	352
August	53	32	17	54	43	133	62	394
September	57	32	17	59	56	151	62	434
October	52	45	20	95	44	159	81	496
November	39	37	25	95	52	152	76	476
December	31	28	20	77	34	188	65	443
Average	44	33	19	60	42	132	74	404

The following table gives the rigs or derricks building, by districts, since 1891. A decline in new work will be noticed since 1895.

Average number of rigs building in the Appalachian oil field from 1891 to 1899, by districts.

District.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Bradford	18	1	3	16	47	52	45	28	44
Allegany	2	1	1	4	14	16	22	16	33
Middle	9	3	6	16	29	32	23	18	19
Venango and Clarion	33	10	18	37	95	67	36	35	60
Butler and Armstrong	38	20	22	49	93	69	40	36	42
Southwest	79	59	67	96	162	152	112	110	132
Southeastern Ohio	3	13	12	15	26	26	19	17	74
Total	182	107	129	233	466	414	297	260	404

In the following table will be found a statement of the number of rigs or derricks building in the Appalachian oil fields, by months, from 1891 to 1899, inclusive.

Rigs building in the Appalachian oil field from 1891 to 1899, by months.

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	233	110	108	166	270	441	320	197	386
February	195	132	107	180	353	450	322	211	417
March	218	111	132	187	380	449	332	216	367
April	186	100	159	233	457	458	362	195	356
May	208	108	144	237	599	439	322	215	393
June	234	89	135	238	564	436	312	227	337
July	182	96	116	245	576	379	287	262	352
August	188	74	114	292	490	360	272	255	394
September	131	98	91	254	486	378	244	305	434
October	156	108	110	269	464	389	301	297	496
November	142	130	143	248	472	419	273	354	476
December	112	122	193	248	476	365	216	392	443
Average	182	107	129	233	466	414	297	260	404

In the following statement will be found the number of wells drilling, by districts and months, for 1899, in the Appalachian field.

Wells in process of drilling in the Appalachian oil field in 1899, by districts and months.

Month.	Bradford.	Allegany.	Middle.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Southeastern Ohio.	Total.
January	29	29	23	43	70	282	87	563
February	49	30	21	44	60	255	139	598
March	34	43	26	55	69	262	72	561
April	43	48	28	69	63	256	84	591
May	42	28	37	69	50	276	72	574
June	40	45	30	70	65	318	75	643
July	48	38	35	67	70	313	76	647
August	63	43	31	76	78	318	85	694
September	56	43	28	89	75	326	73	690
October	45	44	38	86	86	351	72	722
November	48	58	48	77	73	359	84	747
December	39	41	29	71	83	333	63	659
Average	45	41	31	68	70	304	82	641

In the following table will be found a statement of the wells in process of drilling, by districts, yearly, since 1891.

Average number of wells in process of drilling in the Appalachian oil field from 1891 to 1899, by districts.

District.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Bradford	22	3	6	25	54	51	37	29	45
Allegany	8	2	2	7	24	27	26	23	41
Middle	21	10	7	21	39	35	27	20	31
Venango and Clarion	34	7	16	40	93	80	46	41	68
Butler and Armstrong	71	44	40	95	162	112	66	54	70
Southwest	227	166	162	206	313	311	247	244	304
Southeastern Ohio	3	10	13	15	30	33	22	20	82
Total	386	242	246	409	715	649	471	431	641

The following table gives the number of wells drilling, by months, from 1891 to 1899, inclusive, for comparison, over the entire Appalachian field:

Number of wells drilling in the Appalachian oil field from 1891 to 1899, and the average by months.

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	407	264	188	269	418	701	514	311	563
February	410	273	214	282	440	621	433	288	598
March	401	251	206	330	467	667	462	323	561
April	387	230	269	345	635	757	477	333	591
May	380	233	291	410	824	727	521	386	574
June	407	258	305	430	941	682	571	403	643
July	420	204	266	498	902	640	546	405	647
August	406	244	248	484	866	625	463	478	694
September	397	236	233	489	819	556	464	508	690
October	386	246	219	469	794	590	415	535	722
November	351	228	277	451	760	627	401	620	747
December	286	238	233	456	716	595	384	589	659
Average	386	242	246	409	715	649	471	431	641

The following table shows the wells completed, the initial production, dry holes, wells drilling, and the rigs building in the Appalachian field, by months, during 1899.

Well record in the Appalachian oil field in 1899.

Month.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	583	9,633	147	563	386
February	454	9,476	93	598	417
March	626	9,522	150	561	367
April	616	9,187	137	591	356
May	751	11,239	160	574	393
June	809	10,856	172	643	337
July	751	10,557	152	647	352
August	765	10,643	160	694	394
September	803	9,682	165	690	434
October	886	11,832	190	722	496
November	895	10,672	200	747	476
December	813	8,594	194	659	443
Total	8,752	*a* 10,158	1,920	*a* 641	*a* 404

a Average.

Tables under the head of Ohio give detailed information as to wells drilled and initial daily production in that portion of the Appalachian oil fields known as the Corning, Macksburg, Steubenville, Marietta, and Scio districts, and miscellaneous wells in southeastern or southern Ohio, grouped in the previous tables under the head of Macksburg. That portion of the Sistersville pool in southern Ohio is included under the head of the Southwest district.

The remaining portion of the Sistersville pool is in West Virginia and is also a part of the great Southwest district. Detailed information as to the number of wells drilled and initial daily production is given under the head of that State.

OHIO AND STATES OUTSIDE THE APPALACHIAN OIL FIELD.

OHIO.

There are two distinct petroleum producing fields in the State of Ohio. That of the southeastern portion forms a part of the great Appalachian oil basin and its product is classed as Pennsylvania oil. In the northwestern section of the State the oil is found in the Trenton lime rock and owing to the presence of sulphurous compounds is inferior for illuminating purposes to that produced in the southeastern counties along the Ohio River. It is known commercially as Lima oil. The Mecca-Belden district is hardly large enough to be classed as a separate field. It produces a superior grade of natural lubricating oil, but the total yield does not exceed 800 barrels per annum.

Ohio produces more oil than any other State and there was a large increase during 1899 over 1898, all of which was from the southeastern portion producing Appalachian oil. There was a small decrease recorded in the amount of Lima oil production during the year, but owing to higher prices there was a large gain in the value. Both fields showed great activity in field operations and more wells were completed in Ohio during 1899 than in any previous year in the history of the State.

The new Berea grit pool near Scio, in Harrison County, Ohio, which came into prominence at the close of 1898, added over 1,600,000 barrels to the total output of Appalachian petroleum in 1899, and proved the most interesting development of the year. The oil was found in the Berea grit at a depth of about 1,200 feet, and although the wells were not of the gusher character, the territory was uniform and operations proved very profitable. There were 843 wells completed in the Scio pool in 1899 and only 29 of them were dry. The production reached its highest point in May, when the pipe line runs amounted to 188,589 barrels, a daily average of nearly 6,100 barrels for the month. From May on there was a gradual decline and at the close of the year the production of the pool was down to 3,900 barrels a day.

Another Berea grit pool that occasioned much excitement in 1899 was the Bricker, 3 miles northeast of Cadiz, and likewise located in Harrison County. The first strike was situated on the John Bricker farm and started at 200 barrels a day. It was soon surrounded on every side by dry holes and its productive area was found not to exceed 200 acres. At the close of the year the pool contained but seven producing wells although a large amount of money had been expended in attempts to enlarge its productive area. Operators who had looked for the opening up of another district as rich in production as Scio were grievously disappointed.

Washington County ranked next to Harrison in importance during the year and supplied a large amount of profitable territory for the exercise of the drill. There are four well-marked oil-producing formations in southeastern Ohio and all of them are found more or less productive in Washington County. A well may prove a duster in the Cow Run or Mahoning sand and yet make a good producer when drilled to the Keener, Big Injun, or Berea. Other oil-producing sands found in southeastern Ohio are the Mendenhall, the Salt, and the Squaw sands. A lower sand has also been discovered that corresponds with the Gordon of Pennsylvania and West Virginia. The Archers Fork district below Marietta supplied some large wells during the year, and the greatest activity prevailed throughout all the shallow sand sections.

The Jackson Ridge Keener sand pool in Monroe County, the Wilson Run, and Clear Fork pools were all of considerable prominence in 1899, but the wells were not conspicuously large. The Chester Hill development in Morgan County attracted the attention of many operators, but did not furnish anything sensational until after the close of 1899. The efforts to develop a new oil pool near Wellsville, in Columbiana County, were only partially successful.

In the Lima or Trenton rock oil territory, in the northwestern part of Ohio, more wells were completed in 1899 than in 1898 or 1897, but the number fell short of the records established in 1896 and 1895. Additions were made to several of the older producing sections, but nothing in the way of new discoveries of any moment was recorded. Operations were more successful in the counties where oil was first discovered than in the outlying sections. There were some flattering indications of new pools in Wyandot, Putnam, and other frontier counties, but these when more thoroughly tested resulted in nothing but failures and disappointments. At the beginning of the year Frederick Brothers secured a good well on the Hunter farm, south of Carey, in Wyandot County, which created quite a flurry for a few days and then gradually subsided. A little interest was excited by the petroleum showings in two or three gas wells, drilled near Oak Harbor, in Ottawa County, but nothing of any consequence was developed.

The wells pumped a barrel or two of oil a day, which is a common thing among gas wells in that section, as all show more or less petroleum when drilled into the Trenton rock below the gas streak.

A 300-barrel well on the Zerkle farm, northwest of Hume, proved a notable feature during the early part of the year, but it did not result in extending the limits of that once prolific area. The Children's Home pool, south of Lima, supplied a fresh producer that started off at 280 barrels a day from the shale 60 feet above the regular Trenton formation; it made a good record for some little time before being drilled down to the regular oil-bearing rock. A small field, in German Township, Allen County, north of Lima, was opened up in April in territory formerly looked upon as barren, and supplied considerable oil during the year. A large addition was also made to the northwest of the old field in Liberty Township, Hancock County. A number of surprisingly good wells were drilled in the old Cygnet district in Wood County and in the Spencerville field. A considerable stretch of light productive territory was opened up in Webster Township, Wood County, 6 miles east of Bowling Green; and in Henry Township, in the same county, a small area of fair promise was added to the western edge of developments.

The Lucas County field was a prominent factor in Lima oil production during 1899, and though of no great area furnished locations for a large number of profitable producers. The Barnes well on the Condon farm in Oregon Township, which started at 25 barrels an hour, was one of the heaviest strikes of the year. Auglaize County added somewhat to her productive area by the discovery of good wells in Duchouquet Township, north of Wapakoneta. In Liberty Township, Hancock County, the Genesee Oil Company got a good well on the Byall farm by drilling 300 feet into the Trenton rock and finding a deep pay 250 feet below the regular pay streak. There was a considerable amount of deep drilling done in Wood and Hancock counties during the year, but in most cases the results hardly warranted the expense. The best deep-sand pay was found in Wood County, south of Cygnet, but the wells that were improved in yield by deeper drilling did not hold up long. These experiments seem to have demonstrated the fact that there is no uniform deep pay that can be operated with profit in the Trenton rock oil fields as at present defined.

PRODUCTION.

The total petroleum production of the State of Ohio in 1899 was 21,142,108 barrels. Of this amount, 16,377,174 barrels came from the Lima oil fields of the northwestern part of the State and 4,764,135 barrels from the Appalachian oil fields of the southeast. The remaining 799 barrels were credited to the lubricating oil districts of Mecca and Belden. The total production of the State for 1898 was 18,738,708 barrels.

There was an increase of 2,403,400 barrels in the Ohio production during 1899 as compared with a decrease of 2,821,807 barrels during 1898; thus 1899 showed a gain of about 13 per cent in production over 1898, while 1898, as compared with 1897, registered a decline of 13 per cent; in 1897, the decrease from 1896 was 2,380,654 barrels, or nearly 10½ per cent. The production of Lima oil in Ohio amounted to 18,682,677 barrels in 1897 and 20,575,138 barrels in 1896. The production of Lima oil has been declining since 1896; and while the output of the Lima oil fields decreased somewhat during 1899 that of the southeastern districts increased. The decrease in the Lima yield was 213,242 barrels, or 1.29 per cent, while the increase in southeastern Ohio amounted to 2,616,525 barrels, which was equivalent to a gain of over 120 per cent.

The average price of Lima oil advanced from 61¾ cents in 1898 to 89⅞ cents in 1899, a gain of 45 per cent. The increase in the total valuation of all the oil produced in Ohio in 1899 over 1898 was $8,761,094, or nearly 72 per cent. The increase for 1898 over 1897 was $972,212, or only about 9 per cent. The number of wells completed in the Lima oil fields in 1899 was 3,559, as compared with 2,398 in 1898 and 2,486 in 1897. The total number of wells completed in both sections of the State during 1899 was 5,355, as compared with 2,760 in 1898.

The total amount and value of crude petroleum produced in Ohio in all fields in 1898 and 1899 are shown in the following table:

Total amount and value of crude petroleum produced in Ohio in 1898 and 1899.

District.	1898.			1899.		
	Production.	Value.	Price per barrel.	Production.	Value.	Price per barrel.
	Barrels.			*Barrels.*		
Lima	16,590,416	$10,244,582	$0.61¾	16,377,174	$14,718,985	$0.89⅞
Eastern	2,147,610	1,957,010	.91⅛	4,764,135	6,243,075	1.31
Mecca-Belden	682	3,618	5.30½	799	4,244	5.31
Total.	18,738,708	12,205,210	.65	21,142,108	20,966,304	.9917

In the following table will be found the total production of all the crude petroleum in Ohio in 1899, by months, in the several fields. The production of the Mecca-Belden district, being very small, can not be given by months.

Total production of crude petroleum in Ohio in 1899, by months and districts.

[Barrels of 42 gallons.]

Month.	Lima.	Southeastern Ohio.	Mecca-Belden.	Total.
January	1,388,250	217,322		1,605,639
February	1,166,189	249,493		1,415,749
March	1,420,719	359,144		1,779,930
April	1,321,368	365,345		1,686,780
May	1,404,205	417,869		1,822,141
June	1,379,980	423,801		1,803,848
July	1,376,786	470,829		1,847,682
August	1,434,299	477,699		1,912,064
September	1,364,043	449,979		1,814,088
October	1,424,584	466,876		1,891,526
November	1,373,459	438,811		1,812,336
December	1,323,292	426,967		1,750,325
Total	16,377,174	4,764,135	799	21,142,108

The total amount and value of crude petroleum produced in Ohio from 1889 to 1899, inclusive, by districts, are shown in the following table:

Total amount and value of crude petroleum produced in Ohio from 1889 to 1899.

Year.	Lima district.		Southeastern Ohio district.	
	Production.	Value.	Production.	Value.
	Barrels.		*Barrels.*	
1889	12,153,189	$1,822,978	317,037	$340,683
1890	15,014,882	4,504,465	1,108,334	1,127,730
1891	17,315,978	5,281,373	422,883	283,332
1892	15,169,507	5,555,832	1,190,302	662,106
1893	13,646,804	6,448,115	2,601,394	1,664,892
1894	13,607,844	6,531,765	3,183,370	2,670,052
1895	15,850,609	11,372,812	3,693,248	5,018,201
1896	20,575,138	13,723,617	3,365,365	3,966,924
1897	18,682,677	8,967,685	2,877,193	2,262,193
1898	16,590,416	10,244,582	2,147,610	1,957,010
1899	16,377,174	14,718,985	4,764,135	6,243,075

Total amount and value of crude petroleum produced in Ohio from 1889 to 1899—Cont'd.

Year.	Mecca-Belden district.		Total.	
	Production.	Value.	Production.	Value.
	Barrels.		*Barrels.*	
1889	1,240	$10,334	12,471,466	$2,173,995
1890	1,440	12,000	16,124,656	5,644,195
1891	1,440	12,000	17,740,301	5,576,705
1892	3,112	21,101	16,362,921	6,239,039
1893	1,571	11,335	16,249,769	8,124,342
1894	940	4,476	16,792,154	9,206,293
1895	1,376	8,229	19,545,233	16,399,242
1896	666	2,897	23,941,169	17,693,438
1897	645	3,120	21,560,515	11,232,998
1898	682	3,618	18,738,708	12,205,210
1899	799	4,244	21,142,108	20,966,304

In the following table is given the total production of crude petroleum in Ohio for the years 1888 to 1899, by months.

Total production of crude petroleum in Ohio from 1888 to 1899, by months.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1888	444,804	507,686	612,830	656,186	774,267
1889	1,041,655	944,506	1,016,278	1,029,780	1,115,703
1890	948,780	929,810	1,008,933	1,101,773	1,223,241
1891	1,561,039	1,396,474	1,484,045	1,500,142	1,475,339
1892	1,124,194	1,160,634	1,242,936	1,173,952	1,216,416
1893	1,227,363	1,195,698	1,399,648	1,289,982	1,384,090
1894	1,326,282	1,187,891	1,431,894	1,368,268	1,486,678
1895	1,286,468	1,123,784	1,387,882	1,480,228	1,572,718
1896	1,957,875	1,805,698	1,967,188	1,989,262	2,062,582
1897	1,828,136	1,747,124	1,905,148	1,825,884	1,857,766
1898	1,587,504	1,416,519	1,592,048	1,506,532	1,548,481
1899	1,605,639	1,415,749	1,779,930	1,686,780	1,822,141

Total production of crude petroleum in Ohio from 1888 to 1899, by months—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.
1888	889,066	939,287	1,022,009	1,005,422
1889	1,074,384	1,052,430	1,075,008	1,060,982
1890	1,274,209	1,472,974	1,544,291	1,700,227
1891	1,516,362	1,545,298	1,538,210	1,523,826
1892	1,266,712	1,370,135	1,572,657	1,574,336
1893	1,419,758	1,444,572	1,480,285	1,402,213
1894	1,439,144	1,398,304	1,487,528	1,369,409
1895	1,590,936	1,779,452	1,877,470	1,904,985
1896	2,101,507	2,117,849	2,059,532	1,994,503
1897	1,848,213	1,854,656	1,830,399	1,763,199
1898	1,513,862	1,516,145	1,654,040	1,575,293
1899	1,803,848	1,847,682	1,912,064	1,814,088

Year.	October.	November.	December.	Total.
1888	1,064,688	1,017,362	1,077,261	10,010,868
1889	1,048,448	1,030,795	981,497	12,471,466
1890	1,798,413	1,608,883	1,513,122	16,124,656
1891	1,527,490	1,299,737	1,372,339	17,740,301
1892	1,586,173	1,517,198	1,557,578	16,362,921
1893	1,397,125	1,306,883	1,302,152	16,249,769
1894	1,469,457	1,424,926	1,402,373	16,792,154
1895	1,963,297	1,840,501	1,737,512	19,545,233
1896	2,041,301	1,863,720	1,980,152	23,941,169
1897	1,774,937	1,642,421	1,682,632	21,560,515
1898	1,626,896	1,577,918	1,623,470	18,738,708
1899	1,891,526	1,812,336	1,750,325	21,142,108

The total production in Ohio for 1899 increased 2,403,400 barrels over that of the year preceding, which was a gain of about 13 per cent.

The following table gives the production of petroleum in Ohio from the beginning of operations in that State to the close of 1899.

Production of petroleum in Ohio.

Year.	Barrels.	Year.	Barrels.
Previous to 1876	200,000	1889	12,471,466
1876	31,763	1890	16,124,656
1877	29,888	1891	17,740,301
1878	38,179	1892	16,362,921
1879	29,112	1893	16,249,769
1880	38,940	1894	16,792,154
1881	33,867	1895	19,545,233
1882	39,761	1896	23,941,169
1883	47,632	1897	21,560,515
1884	90,181	1898	18,738,708
1885	661,580	1899	21,142,108
1886	1,782,970	Total	218,726,373
1887	5,022,632		
1888	10,010,868		

LIMA DISTRICT.

The Lima, Buckeye, or Trenton Rock oil field, as it is variously termed, is the most important productive area yet discovered in Ohio. The product comes from a limestone formation instead of a sandstone, as in the southeastern part of the State, and contains a considerable quantity of sulphureted compounds which renders it rather refractory for refining purposes. It also contains a smaller percentage of illuminating oil than the Eastern or Pennsylvania product.

The Lima district proper lies entirely in northwestern Ohio, covering portions of Wood, Hancock, Allen, Auglaize, Sandusky, Mercer, Van Wert, Seneca, Lucas, and Shelby counties. It produced 77 per cent of all the oil produced in Ohio in 1899 as compared with 88 per cent in 1898. The first well to produce oil was drilled at Findlay, Hancock County, in the fall of 1884. The Lima oil production comes entirely from the Trenton Rock formation.

PRODUCTION OF LIMA DISTRICT.

The following table gives the production of the Lima (Ohio) district, beginning with 1886 and ending with 1899:

Production of petroleum in the Lima (Ohio) district from 1886 to 1899.

Year.	Barrels.	Year.	Barrels.
1886	1,064,025	1893	13,646,804
1887	4,650,375	1894	13,607,844
1888	9,682,683	1895	15,850,609
1889	12,153,189	1896	20,575,138
1890	15,014,882	1897	18,682,677
1891	17,315,978	1898	16,590,416
1892	15,169,507	1899	16,377,174

In the following table is found the production of petroleum in the Lima (Ohio) field from 1887 to 1899, by months, so far as obtainable:

Production of petroleum in the Lima (Ohio) field from 1887 to 1899.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1887	131,011	206,026	303,084	352,798	449,062
1888	422,125	479,824	586,781	629,932	745,896
1889	1,016,697	921,185	989,793	1,004,969	1,090,638
1890	911,947	888,978	955,620	1,040,924	1,142,954
1891	1,471,858	1,355,734	1,455,628	1,470,661	1,446,284
1892	1,090,173	1,127,481	1,200,305	1,128,253	1,165,750
1893	1,037,358	985,620	1,161,384	1,072,850	1,179,808
1894	1,116,979	974,091	1,177,837	1,099,453	1,203,229
1895	1,034,489	900,530	1,111,346	1,194,799	1,287,167
1896	1,635,925	1,523,866	1,673,595	1,697,848	1,775,858
1897	1,534,285	1,485,039	1,638,755	1,570,621	1,590,956
1898	1,408,076	1,251,149	1,409,400	1,326,696	1,366,758
1899	1,388,250	1,166,189	1,420,719	1,321,368	1,404,205

Production of petroleum in the Lima (Ohio) field from 1887 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.
1887	474, 535	389, 997	490, 862	465, 743
1888	862, 106	905, 218	995, 938	979, 943
1889	1, 050, 269	1, 029, 707	1, 050, 152	1, 038, 072
1890	1, 175, 821	1, 354, 672	1, 411, 998	1, 559, 473
1891	1, 491, 228	1, 514, 607	1, 509, 262	1, 492, 115
1892	1, 210, 523	1, 300, 197	1, 461, 020	1, 422, 534
1893	1, 213, 521	1, 231, 010	1, 258, 289	1, 181, 493
1894	1, 165, 190	1, 131, 081	1, 212, 090	1, 090, 626
1895	1, 300, 058	1, 474, 115	1, 540, 149	1, 527, 085
1896	1, 822, 817	1, 843, 477	1, 789, 341	1, 739, 122
1897	1, 589, 063	1, 608, 730	1, 603, 336	1, 546, 131
1898	1, 336, 812	1, 352, 640	1, 472, 428	1, 399, 457
1899	1, 379, 980	1, 376, 786	1, 434, 299	1, 364, 043

Year.	October.	November.	December.	Total.
1887	444, 941	458, 612	483, 704	4, 650, 375
1888	1, 036, 712	988, 997	1, 049, 211	9, 682, 683
1889	1, 019, 961	997, 825	943, 921	12, 153, 189
1890	1, 660, 069	1, 495, 099	1, 417, 327	15, 014, 882
1891	1, 499, 834	1, 271, 189	1, 337, 578	17, 315, 978
1892	1, 379, 909	1, 328, 548	1, 354, 814	15, 169, 507
1893	1, 154, 641	1, 084, 324	1, 086, 506	13, 646, 804
1894	1, 165, 938	1, 146, 686	1, 124, 644	13, 607, 844
1895	1, 579, 693	1, 494, 985	1, 406, 193	15, 850, 609
1896	1, 770, 493	1, 612, 298	1, 690, 498	20, 575, 138
1897	1, 571, 760	1, 458, 688	1, 485, 313	18, 682, 677
1898	1, 446, 838	1, 397, 247	1, 422, 915	16, 590, 416
1899	1, 424, 584	1, 373, 459	1, 323, 292	16, 377, 174

WELL RECORDS IN LIMA DISTRICT.

The table below shows the wells completed each month during the year 1899 in the Lima (Ohio) district.

Total number of wells completed in the Lima (Ohio) district in 1899.

Month.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Lucas.	Mercer.	Shelby.	Seneca.
January	52	21	41	30	80	17	6	6	9
February	37	12	37	26	56	10	4	3	4
March	65	20	28	36	69	16	12	1	3
April	54	12	26	19	40	17	4	1	1
May	58	24	31	42	69	13	9	3	4
June	56	30	44	39	116	26	14	5	8
July	55	27	33	40	103	16	8	3	4
August	78	26	47	37	96	14	17	2	5
September	80	23	56	42	116	20	16	0	7
October	78	26	53	45	99	13	13	0	1
November	97	29	56	53	101	16	10	1	5
December	75	26	45	43	110	11	16	0	4
Total	785	276	497	452	1,055	189	129	25	55

Month.	Ottawa.	Van Wert.	Putnam.	Wyandot.	Hardin.	Henry.	Darke.	Logan.	Total.
January	2	1	1	1	0	0	0	0	267
February	2	0	1	0	0	0	0	0	192
March	0	2	0	1	1	0	0	0	254
April	2	0	0	0	0	0	0	0	176
May	4	0	0	1	0	0	0	0	258
June	4	2	1	4	0	1	0	0	350
July	1	2	1	2	0	0	0	1	296
August	2	3	0	2	0	0	0	1	330
September	3	9	0	2	0	0	0	1	375
October	3	7	0	3	0	0	1	0	342
November	3	5	0	3	0	0	0	0	379
December	5	2	0	3	0	0	0	0	340
Total	31	33	4	22	1	1	1	3	3,559

Number of wells completed in Lima (Ohio) district from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Allen	96	38	20	63	215	226	212	279	785
Auglaize	376	176	214	348	482	308	303	239	276
Hancock	140	91	80	340	493	679	432	301	497
Lucas	......	......	3	22	20	92	232	182	189
Mercer	......	32	39	247	387	261	118	90	129
Ottawa	......	8	......	......	3	15	38	18	31
Sandusky	233	319	428	543	994	851	258	269	452
Seneca	......	29	14	7	78	238	53	67	55
Shelby	......	......	1	......	......	......	7	84	25
Van Wert	......	1	0	4	130	149	14	9	33
Wood	622	732	760	885	1,646	1,592	791	837	1,055
Wyandot	......	11	8	8	37	40	22	12	22
Miscellaneous	107	9	2	5	4	7	6	7	10
Total	1,574	1,446	1,569	2,472	4,489	4,458	2,486	2,394	3,559

Number of wells completed in the Lima (Ohio) district from 1890 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1890.	44	62	......	......	147	165	224	271	307	319	243	187	1,969
1891.	142	123	129	156	116	143	144	138	157	134	104	88	1,574
1892.	67	82	93	93	93	121	134	166	171	174	147	105	1,446
1893.	100	85	163	135	128	160	152	133	131	120	132	130	1,569
1894.	130	175	179	205	248	230	233	219	204	226	214	209	2,472
1895.	200	158	244	316	412	461	484	519	462	427	470	336	4,489
1896.	328	355	370	432	504	513	396	337	346	279	299	299	4,458
1897.	252	193	210	215	226	211	242	193	216	196	191	141	2,486
1898.	129	88	89	118	114	162	206	297	285	302	319	285	2,394
1899.	267	192	254	176	258	350	296	330	375	342	379	340	3,559

It will be noted in the table that follows that the average initial production of the new wells completed in 1899 was 4,958 barrels per month. This amount is one-twelfth the total initial production of 59,497 barrels, which divided by 3,164, the total number of productive wells completed during the year, gives 18.8 barrels as the average initial daily production of each paying well drilled in northwestern Ohio in 1899. The average for 1898 was 23 barrels; for 1897, 27 barrels; for 1896, 21.3 barrels; for 1895, 23 barrels. The average for the past year is the smallest of the five, and the great decrease shows conclusively that the best of the productive oil territory in northwestern Ohio has been pretty thoroughly drilled over.

Initial daily production of wells completed in the Lima (Ohio) district in 1899.

[Barrels of 42 gallons.]

Month.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Lucas.	Mercer.
January	1,015	245	855	530	1,550	515	70
February	955	130	707	360	695	285	65
March	1,257	150	405	452	954	390	245
April	1,255	235	520	290	535	385	35
May	870	330	615	655	845	235	310
June	1,220	280	915	395	2,475	465	255
July	1,410	240	545	505	1,685	185	140
August	1,820	240	960	480	1,425	240	205
September	1,770	258	920	565	1,670	280	245
October	1,635	265	1,025	600	1,635	195	160
November	2,140	325	940	725	1,745	150	130
December	1,455	305	860	484	1,525	85	140
Average	1,400	250	772	503	1,395	284	167

Month.	Shelby.	Seneca.	Ottawa.	Van Wert.	Miscellaneous.	Total.
January	190	75	15	0	25	5,085
February	35	55	50	0	5	3,342
March	0	60	0	0	10	3,923
April	50	20	15	0	0	3,340
May	80	75	95	0	25	4,135
June	55	110	50	5	0	6,225
July	30	15	15	30	10	4,810
August	25	40	15	110	15	5,575
September	0	50	120	140	10	6,028
October	0	30	45	80	30	5,700
November	10	50	30	35	15	6,295
December	0	25	110	35	15	5,039
Average	40	50	47	36	14	4,958

Average initial daily production of wells completed in Lima (Ohio) district 1891 to 1899, by counties.

[Barrels of 42 gallons.]

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Allen	243	93	33	83	285	298	298	463	1,400
Auglaize	1,997	616	713	710	925	468	1,028	362	250
Hancock	525	389	216	739	694	1,092	644	453	772
Lucas	......	......	17	81	16	200	659	494	284
Mercer	......	91	64	505	838	471	161	121	167
Ottawa	......	......	......	......	1	17	57	29	47
Sandusky	576	2,814	1,675	1,940	1,732	1,435	363	357	503
Seneca	......	54	5	5	136	412	59	74	50
Shelby	......	......	1	......	......	......	11	254	40
Van Wert	......	......	......	3	290	267	14	9	36
Wood	2,663	3,789	3,255	1,768	2,567	2,375	1,502	1,471	1,395
Wyandot	......	26	1	4	46	45	18	4	12
Miscellaneous	224	......	1	4	2	3	4	6	2
Total	6,228	7,872	5,980	5,843	7,532	7,083	4,818	4,097	4,958

Initial daily production of new wells in the Lima (Ohio) district from 1890 to 1899, by months.

[Barrels of 42 gallons.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1890	....	....	....	....	....	....	....
1891	5,858	5,474	4,428	6,543	4,411	6,667	8,461
1892	2,853	4,485	3,973	4,665	4,750	8,314	11,648
1893	5,510	4,809	6,241	5,477	6,858	9,701	9,588
1894	3,853	4,211	4,486	5,586	7,291	6,391	5,637
1895	4,432	3,753	5,281	6,208	8,161	9,772	9,011
1896	5,651	6,704	7,885	9,335	9,902	9,670	6,885
1897	4,710	3,600	4,820	4,040	4,175	4,525	5,855
1898	2,765	2,105	2,085	2,540	3,205	3,250	4,280
1899	5,085	3,342	3,923	3,340	4,135	6,225	4,810

Initial daily production of new wells in the Lima (Ohio) district from 1890 to 1899, by months—Continued.

[Barrels of 42 gallons.]

Year.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1890	18,944	16,309	17,426	13,779	8,424	14,976
1891	8,427	7,855	8,033	5,592	2,989	6,228
1892	14,631	12,908	13,772	7,554	4,907	7,872
1893	5,124	6,752	4,223	4,205	3,275	5,980
1894	5,642	5,020	5,991	10,464	5,539	5,843
1895	10,025	9,175	8,586	9,695	6,284	7,532
1896	6,175	5,640	5,355	5,630	6,171	7,083
1897	6,740	6,283	5,955	4,145	2,975	4,818
1898	6,195	5,900	5,985	6,025	4,830	4,097
1899	5,575	6,028	5,700	6,295	5,039	4,958

The following table shows that 395 of the total number of wells drilled in the Lima oil district in 1899 were destitute of oil in paying quantities, as compared with 270 in 1898, 384 in 1897, and 550 in 1896. This leaves 3,164 productive wells completed in 1899, as against 2,124 in 1898, 2,102 in 1897, and 3,908 in 1896. The increase in productive wells drilled in 1899 over 1898 was 1,040. Notwithstanding the large number of productive wells completed in the Lima oil district in 1899, the production for the year was 213,242 barrels less than for the year preceding.

Total number of dry holes drilled in the Lima (Ohio) district in 1899.

Month.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Lucas.	Mercer.
January	11	5	1	3	5	2	1
February	6	0	6	1	2	1	0
March	12	7	2	3	6	4	1
April	10	1	5	1	9	1	0
May	10	6	1	3	9	0	1
June	7	8	2	3	6	1	1
July	4	7	2	2	6	4	0
August	8	9	7	0	2	0	4
September	8	4	9	2	4	2	1
October	6	9	9	1	8	0	2
November	5	9	8	1	12	1	1
December	9	7	6	1	10	3	4
Total	96	72	58	21	79	19	16

Total number of dry holes drilled in the Lima (Ohio) district in 1899—Continued.

Month.	Shelby.	Seneca.	Ottawa.	Van Wert.	Putnam.	Miscellaneous.	Total.
January	0	0	0	1	1	0	30
February	1	0	0	0	0	0	17
March	1	0	0	2	0	1	39
April	0	0	1	0	0	0	28
May	0	0	0	0	0	0	30
June	1	0	0	1	1	5	36
July	1	1	0	0	1	2	30
August	0	0	1	0	0	2	33
September	0	0	0	1	0	1	32
October	0	0	1	0	0	0	36
November	0	0	0	1	0	2	40
December	0	1	1	0	0	2	44
Total	4	2	4	6	3	15	395

Number of dry holes drilled in the Lima (Ohio) field from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Allen	11	3	4	13	47	52	43	43	96
Auglaize	44	19	30	50	68	62	59	44	72
Hancock	25	13	4	64	84	103	73	38	58
Lucas	......	......	......	7	9	11	12	14	19
Mercer	......	10	15	57	40	43	32	10	16
Ottawa	......	8	......	......	2	5	6	2	4
Sandusky	35	34	39	47	70	41	19	9	21
Seneca	......	10	7	......	10	10	6	1	2
Shelby	......	......	......	......	......	......	2	7	4
Van Wert	......	1	......	1	13	24	4	1	6
Wood	92	77	97	139	203	181	114	91	79
Wyandot	......	4	6	5	15	15	11	4	10
Miscellaneous	43	4	1	1	3	3	3	6	8
Total	250	183	203	384	564	550	384	270	395

Total number of dry holes drilled in the Lima (Ohio) district from 1890 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1890.	3	2	.....	.....	4	11	10	23	30	32	37	41	193
1891.	28	27	23	28	14	18	22	14	26	20	17	13	250
1892.	9	9	8	13	10	18	16	18	27	22	18	15	183
1893.	12	15	20	24	18	19	18	12	14	16	13	22	203
1894.	17	41	37	27	32	41	30	34	35	27	28	35	384
1895.	33	19	38	33	66	65	70	48	59	48	49	36	564
1896.	43	44	57	39	55	63	47	35	52	26	42	47	550
1897.	28	28	30	32	31	25	36	26	33	39	43	33	384
1898.	21	18	10	18	13	16	21	37	27	25	35	29	270
1899.	30	17	39	28	30	36	30	33	32	36	40	44	395

Wells completed in the Lima (Ohio) district from 1890 to 1899.

Year.	Number.	Dry.	Total productive.
1890	1,969	193	1,776
1891	1,574	250	1,324
1892	1,446	183	1,263
1893	1,569	203	1,366
1894	2,472	384	2,088
1895	4,489	564	3,925
1896	4,458	550	3,908
1897	2,486	384	2,102
1898	2,394	270	2,124
1899	3,559	395	3,164

In the following table giving the number of drilling wells under way at the close of each month for 1899 it will be noted that operations continued with great activity throughout the year. There were 300 wells drilling and 163 rigs under way in the Lima fields at the close of 1899, as contrasted with 124 rigs and 278 drilling wells on December 31, 1898, and 82 rigs and 128 drilling wells on December 31, 1897. The average of wells drilling was 257 for the close of each month in 1899, as against 175 in 1898 and 177 in 1897.

Total number of wells drilling in the Lima (Ohio) district in 1899.

Month.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Lucas.
January	39	12	35	22	88	12
February	54	15	26	25	81	13
March	43	5	28	16	64	13
April	31	11	23	15	52	6
May	37	19	39	27	89	16
June	46	15	42	30	94	12
July	50	18	44	13	91	15
August	57	16	44	27	101	16
September	59	15	41	32	106	14
October	75	21	44	28	129	18
November	65	22	49	32	127	16
December	58	24	59	25	99	10
Average	51	16	40	25	93	13

Month.	Mercer.	Shelby.	Seneca.	Ottawa.	Van Wert.	Miscellaneous.	Total.
January	7	3	3	3	0	1	225
February	5	6	2	3	1	1	232
March	2	1	2	4	0	....	178
April	7	3	2	4	0	1	155
May	8	3	2	1	1	1	243
June	8	1	1	1	1	2	253
July	11	2	1	2	2	2	251
August	6	2	4	2	6	3	284
September	10	1	0	3	4	4	289
October	8	1	6	3	1	4	338
November	14	0	3	9	1	4	342
December	10	0	3	5	3	4	300
Average	8	2	2	3	2	2	257

Average number of wells drilling in the Lima (Ohio) field from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Allen	5	3	2	4	16	16	13	22	51
Auglaize	19	10	13	17	33	16	19	14	16
Hancock	7	6	7	18	40	54	33	27	40
Lucas	......	......	......	3	5	9	20	13	13
Mercer	......	2	2	12	22	18	9	7	8
Ottawa	......	1	......	......	......	1	3	1	3
Sandusky	11	16	23	27	64	41	14	15	25
Seneca	......	2	1	......	9	14	2	4	2
Shelby	......	......	......	......	......	......	1	5	2
Van Wert	......	......	......	......	8	7	1	......	2
Wood	35	46	50	49	110	113	59	65	93
Wyandot	......	1	1	1	4	4	2	1	2
Miscellaneous	8	1	......	......	1	1	1	1	......
Total	85	88	99	131	312	294	177	175	257

Number of wells drilling in the Lima (Ohio) district, at the close of each month, from 1890 to 1899.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1890.	47	59	......	......	135	188	237	182	238	294	148	111	164
1891.	90	105	94	82	79	90	90	93	85	88	67	53	85
1892.	61	78	76	51	64	95	101	112	120	114	106	81	88
1893.	72	78	88	92	117	119	103	101	89	102	118	114	99
1894.	120	113	127	138	127	139	117	138	136	136	138	140	131
1895.	132	176	214	269	302	369	397	413	404	435	306	331	312
1896.	327	317	338	368	371	293	282	251	251	240	243	249	294
1897.	217	221	200	187	148	189	160	184	168	178	141	128	177
1898.	94	81	94	98	99	174	210	224	217	246	288	278	175
1899.	225	232	178	155	243	253	251	284	289	338	342	300	257

There were 163 rigs up and building in the Lima district at the close of 1899, as compared with 124 at the close of 1898 and 82 at the close of 1897. The average of new rigs built was 128 per month in 1899, 109 per month in 1898, 90 in 1897, and 159 in 1896.

Total number of rigs or derricks building in the Lima (Ohio) district in 1899.

Month.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Lucas.
January	17	5	22	16	43	12
February	24	3	18	17	40	11
March	9	8	13	21	32	9
April	16	5	15	20	37	10
May	10	6	17	12	51	9
June	15	7	17	14	50	7
July	17	15	14	12	51	2
August	16	5	17	10	46	10
September	20	11	27	19	56	7
October	20	8	27	24	70	7
November	16	7	32	15	54	1
December	22	8	37	18	64	5
Average	17	7	21	17	50	8

Month.	Mercer.	Shelby.	Seneca.	Ottawa.	Van Wert.	Wyandot.	Total.
January	1	1	2	2	1	0	122
February	3	0	2	2	2	0	122
March	0	0	0	3	1	0	96
April	2	0	1	2	1	0	109
May	3	2	2	2	1	1	116
June	1	0	1	1	1	0	114
July	0	0	2	0	2	0	115
August	8	0	2	2	3	0	119
September	1	0	3	0	5	1	150
October	9	0	0	1	2	0	168
November	6	0	4	0	2	3	140
December	4	0	1	1	2	1	163
Average	3	....	2	1	2	....	128

Average number of rigs building in Lima (Ohio) field 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Allen	9	5	1	2	8	6	3	9	17
Auglaize	22	17	9	9	24	8	7	8	7
Hancock	12	9	4	10	25	24	11	12	21
Lucas	......	......	......	2	3	2	6	8	8
Mercer	......	5	2	11	20	8	4	3	3
Ottawa	......	1	......	......	......	......	1	1	1
Sandusky	17	17	11	18	49	32	16	17	17
Seneca	......	1	......	......	3	7	1	1	2
Shelby	......	......	......	......	......	......	......	1	....
Van Wert	......	......	......	......	6	4	3	2	2
Wood	54	51	38	34	104	65	36	46	50
Wyandot	......	2	......	1	2	1	1	......	....
Miscellaneous	6	......	1	......	......	2	1	1	....
Total	120	108	66	87	244	159	90	109	128

Rigs building in the Lima (Ohio) district from 1890 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1890.	56	69	......	......	173	239	248	212	210	194	149	109	166
1891.	120	137	155	117	115	123	137	120	117	106	91	99	120
1892.	95	115	106	112	113	104	128	126	121	112	112	49	108
1893.	62	70	63	58	90	72	52	52	61	76	66	69	66
1894.	60	83	90	88	85	76	68	95	86	92	112	110	87
1895.	114	171	208	245	305	339	317	282	294	264	194	195	244
1896.	205	216	231	201	206	147	130	106	114	120	138	91	159
1897.	94	108	102	97	100	94	76	79	71	85	88	82	90
1898.	81	62	79	75	96	122	120	108	131	146	169	124	109
1899.	122	122	96	109	116	114	115	119	150	168	140	163	128

The following table shows the wells completed, the initial production, the dry holes, wells drilling, and rigs building in the Lima (Ohio) district in 1899:

Well record in the Lima (Ohio) district in 1899.

Month.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	267	5,085	30	225	122
February	192	3,342	17	232	122
March	254	3,923	39	178	96
April	176	3,340	28	155	109
May	258	4,135	30	243	116
June	350	6,225	36	253	114
July	296	4,810	30	251	115
August	330	5,575	33	284	119
September	375	6,028	32	289	150
October	342	5,700	36	338	168
November	379	6,295	40	342	140
December	340	5,039	44	300	163
Total	3,559	*a*4,958	395	*a*257	*a*128

a Average.

PIPE-LINE RUNS IN THE LIMA-INDIANA FIELD.

The term Lima-Indiana field is used to include all of the petroleum produced in the Lima (Ohio) and the Indiana fields, which embraces all of the Trenton limestone production. In the following table of pipe-line runs it is not possible to separate the petroleum carried out of Ohio from that carried out of Indiana, and therefore the runs and shipments from these States are combined. As has been before mentioned in this report, pipe-line runs are not production. This is especially true of the Lima-Indiana field. The production by States is quite accurately given under that head.

Pipe-line runs, Lima-Indiana field, from 1887 to 1899.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1887	164, 474	207, 026	303, 084	352, 798	449, 062
1888	359, 860	428, 008	534, 588	587, 043	705, 045
1889	973, 980	800, 828	830, 559	845, 377	932, 067
1890	683, 750	622, 799	676, 175	842, 416	887, 590
1891	1, 241, 154	1, 147, 947	1, 255, 611	1, 202, 583	1, 191, 147
1892	971, 607	1, 008, 069	1, 083, 801	1, 042, 087	1, 064, 478
1893	1, 049, 778	974, 944	1, 163, 641	1, 074, 290	1, 187, 939
1894	1, 265, 267	1, 106, 493	1, 353, 591	1, 295, 619	1, 424, 182
1895	1, 213, 841	1, 029, 385	1, 291, 355	1, 405, 424	1, 540, 972
1896	1, 739, 291	1, 631, 939	1, 795, 745	1, 859, 882	1, 945, 979
1897	1, 547, 658	1, 589, 905	1, 733, 521	1, 647, 997	1, 685, 011
1898	1, 457, 122	1, 275, 150	1, 476, 996	1, 387, 212	1, 406, 450
1899	1, 430, 374	1, 189, 438	1, 497, 886	1, 399, 097	1, 499, 500

Year.	June.	July.	August.	September.	October.
1887	474, 535	389, 997	490, 162	465, 743	444, 941
1888	774, 710	896, 034	975, 235	868, 826	939, 468
1889	843, 844	805, 744	968, 449	875, 201	850, 077
1890	916, 289	1, 105, 885	1, 149, 877	1, 289, 577	1, 342, 158
1891	1, 207, 884	1, 236, 291	1, 240, 841	1, 252, 375	1, 257, 986
1892	1, 099, 145	1, 190, 015	1, 246, 949	1, 232, 385	1, 264, 536
1893	1, 245, 880	1, 289, 991	1, 390, 894	1, 315, 933	1, 302, 295
1894	1, 402, 417	1, 366, 310	1, 469, 372	1, 325, 352	1, 405, 042
1895	1, 541, 221	1, 713, 937	1, 752, 150	1, 778, 653	1, 822, 002
1896	2, 026, 387	2, 016, 564	1, 953, 876	1, 883, 814	1, 896, 033
1897	1, 689, 456	1, 702, 339	1, 668, 287	1, 618, 488	1, 649, 170
1898	1, 394, 877	1, 397, 520	1, 528, 979	1, 452, 312	1, 464, 780
1899	1, 482, 070	1, 463, 789	1, 517, 355	1, 425, 367	1, 482, 681

Pipe-line runs, Lima-Indiana field, from 1887 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	November.	December.	Total.	Average per month.
1887	458, 613	483, 704	4, 684, 139	390, 345
1888	891, 999	938, 188	8, 899, 004	741, 584
1889	774, 073	755, 553	10, 255, 752	854, 646
1890	1, 215, 960	1, 186, 434	11, 918, 910	993, 243
1891	1, 070, 131	1, 211, 820	14, 515, 770	1, 209, 648
1892	1, 209, 953	1, 244, 712	13, 657, 737	1, 138, 145
1893	1, 230, 658	1, 224, 952	14, 451, 195	1, 204, 266
1894	1, 334, 334	1, 326, 371	16, 074, 350	1, 339, 529
1895	1, 705, 506	1, 621, 184	18, 415, 630	1, 534, 636
1896	1, 681, 715	1, 778, 786	22, 210, 011	1, 850, 834
1897	1, 566, 921	1, 571, 761	19, 670, 514	1, 639, 210
1898	1, 415, 198	1, 472, 301	17, 128, 897	1, 427, 408
1899	1, 430, 518	1, 365, 729	17, 183, 804	1, 431, 984

SHIPMENTS OF PETROLEUM FROM THE LIMA-INDIANA FIELD.

Shipments represent the demand upon the pipe lines and furnish about as close an estimate of the actual consumption as can be obtained. In the following tables are given the shipments of the Buckeye pipe lines from the Lima-Indiana districts, by months, from 1887 to 1899, inclusive. The shipments for 1899 were 4,445,712 barrels in excess of the runs, which amount was drawn from the surplus production of previous years. In 1898 the shipments exceeded the runs by 7,323,523 barrels, but during 1897 the runs and shipments were very close together, and there was an increase in the stocks of 365,871 barrels.

Shipments of crude petroleum from the Lima-Indiana field from 1887 to 1899.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1887	....	10, 957	32, 613	77, 900	101, 306
1888	81, 569	207, 040	243, 964	210, 725	159, 620
1889	367, 524	362, 807	391, 026	340, 889	309, 238
1890	156, 085	111, 604	123, 125	115, 223	169, 662
1891	968, 887	837, 928	330, 448	336, 854	1, 078, 489
1892	1, 355, 362	1, 346, 541	1, 532, 606	1, 512, 358	1, 427, 753
1893	1, 306, 612	1, 270, 595	1, 390, 646	1, 205, 748	1, 321, 782
1894	1, 199, 752	1, 109, 110	1, 247, 295	1, 210, 391	1, 150, 298
1895	1, 473, 730	1, 289, 686	1, 409, 761	1, 206, 172	1, 212, 061
1896	1, 802, 361	1, 593, 328	1, 618, 117	1, 546, 888	1, 574, 627
1897	1, 672, 838	1, 795, 876	1, 724, 306	1, 585, 187	1, 762, 085
1898	1, 889, 062	1, 944, 249	2, 203, 051	2, 058, 630	2, 015, 854
1899	1, 715, 132	1, 604, 793	1, 853, 725	1, 797, 810	1, 882, 240

Shipments of crude petroleum from the Lima-Indiana field from 1887 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.	October.
1887	104,440	174,824	20,019	30,944	43,168
1888	179,192	227,707	401,175	301,316	370,378
1889	352,886	361,694	464,325	626,207	715,386
1890	700,422	874,121	846,360	813,817	723,725
1891	923,605	997,681	1,166,054	1,260,598	1,408,343
1892	1,492,543	1,389,501	1,342,949	1,125,335	1,315,994
1893	1,235,843	1,152,374	1,040,860	1,038,819	1,196,018
1894	1,303,957	1,023,316	1,238,183	1,023,232	1,198,801
1895	1,279,618	1,302,596	1,298,502	1,452,640	1,507,992
1896	1,667,914	1,617,519	1,745,657	1,702,721	1,704,065
1897	1,750,613	1,841,908	1,478,129	1,655,593	1,591,449
1898	1,975,584	1,967,098	2,223,759	2,032,483	2,186,912
1899	1,845,469	1,923,422	1,779,080	1,870,535	2,014,745

Year.	November.	December.	Total.	Average per month.
1887	78,827	76,327	751,325	68,302
1888	287,934	382,448	3,053,068	254,422
1889	759,702	750,244	5,801,928	483,494
1890	657,614	907,548	6,199,306	516,609
1891	1,391,400	1,454,578	12,154,865	1,012,905
1892	1,323,204	1,340,734	16,504,880	1,375,407
1893	1,262,130	1,230,216	14,651,643	1,220,970
1894	1,285,861	1,463,566	14,453,762	1,204,480
1895	1,587,449	1,810,159	16,830,366	1,402,531
1896	1,720,720	1,727,549	20,021,466	1,668,456
1897	1,353,321	1,881,121	20,092,426	1,674,369
1898	2,054,504	1,851,234	24,452,420	2,033,535
1899	1,730,368	1,612,197	21,629,516	1,802,460

STOCKS OF CRUDE PETROLEUM IN LIMA-INDIANA FIELD.

The following tables represent stocks in iron tanks of the Lima-Indiana oil held by the Buckeye Pipe Line Company at the close of each month from 1887 to 1899. The reduction of stocks during 1898 amounted to over seven and a half million barrels, or nearly one-third of the amount on hand at the beginning of the year. There was a further reduction of 4,634,965 barrels in 1899, and at the close of the year the stocks of Lima oil were the lowest known in eleven years. On December 31, 1899, the total net stocks of Lima oil amounted to

10,545,927 barrels as compared with 15,180,892 barrels at the close of 1898, and 22,762,779 barrels at the close of 1897. On the same date the net stocks in the eastern oil fields were 13,451,191 barrels. This added to the Lima stocks would give a total for both fields of 23,997,118 barrels, and make a net reduction of 2,970,377 barrels. Eastern oil stocks were increased 1,664,588 barrels in 1899. The total net stocks of Lima oil at the close of 1898 were 15,180,892 barrels, as compared with 22,762,779 barrels at the close of 1897. On December 31, 1898, the stock in the eastern oil fields amounted to 11,541,753 barrels, making a total of 26,722,645 barrels of crude oil in iron tanks, as against 33,949,683 barrels on December 31, 1897. The decrease in stocks in the Lima-Indiana field was 7,581,887 barrels, while the increase in the eastern oil stocks was 752,101, making a net decline for 1898 in both fields of 6,829,786 barrels. There was an increase of stocks in both fields of 1,630,193 barrels during 1897.

Total stocks of crude petroleum in the Lima-Indiana field, at the close of each month, from 1887 to 1899.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.
1887....	....	847,817	1,118,288	1,393,186	1,740,942
1888....	4,367,355	4,588,323	4,949,446	5,367,401	5,980,283
1889....	10,415,880	10,852,202	11,288,793	11,792,707	12,413,137
1890....	14,104,018	14,180,090	14,241,340	14,153,259	14,298,966
1891....	21,233,645	21,537,789	21,957,948	22,319,191	22,424,364
1892....	21,692,318	21,350,912	20,896,185	20,425,914	20,062,639
1893....	18,355,492	18,059,846	17,877,265	17,747,249	17,616,527
1894....	18,565,823	18,566,158	18,675,275	18,763,242	19,041,624
1895....	19,898,378	19,642,870	19,524,463	19,723,715	20,052,627
1896....	21,431,778	21,473,447	21,651,075	21,964,069	22,335,420
1897....	23,174,324	22,968,353	22,977,567	23,040,378	22,963,304
1898....	22,280,840	21,611,740	20,885,685	20,215,331	19,605,927
1899....	14,896,134	14,480,779	14,126,046	13,724,911	13,339,158

Total stocks of crude petroleum in the Lima-Indiana field, at the close of each month, from 1887 to 1899—Continued.

[Barrels of 42 gallons.]

Year.	June.	July.	August.	September.
1887	2,111,037	2,326,211	2,632,828	2,957,900
1888	6,593,165	7,282,088	7,852,705	8,392,493
1889	12,902,628	13,344,795	13,846,765	14,092,706
1890	14,513,553	14,744,004	19,086,736	19,843,950
1891	22,704,034	22,930,048	22,993,496	22,975,470
1892	19,668,894	19,467,900	19,505,399	19,150,058
1893	17,642,117	17,779,733	18,129,767	18,408,814
1894	19,142,598	19,504,651	19,736,628	20,040,748
1895	20,314,230	20,725,571	21,179,219	21,351,757
1896	22,693,894	23,094,851	23,304,312	23,091,525
1897	22,902,147	22,762,578	22,952,736	22,840,818
1898	19,025,220	18,455,642	17,690,914	17,021,263
1899	12,974,125	12,513,792	12,250,599	11,705,431

Year.	October.	November.	December.	Average.
1887	3,359,674	3,739,459	4,148,469	2,397,801
1888	8,920,086	9,499,482	9,810,714	6,966,962
1889	14,224,747	14,554,662	14,105,149	12,819,514
1890	20,442,065	20,967,258	20,971,395	16,795,553
1891	22,722,465	22,375,030	22,103,705	22,456,438
1892	18,800,715	18,687,464	18,604,442	19,859,403
1893	18,527,901	18,499,669	18,497,340	18,095,143
1894	20,246,989	20,295,461	20,158,266	19,394,788
1895	21,565,766	21,683,823	21,494,848	20,596,439
1896	23,290,538	23,251,533	23,302,770	22,573,768
1897	22,858,539	23,072,139	22,762,779	22,939,639
1898	16,299,131	15,559,825	15,180,892	18,652,701
1899	11,123,367	10,748,517	10,545,927	12,702,399

PRICES OF CRUDE PETROLEUM IN THE LIMA-INDIANA FIELD.

In the following table are given the average monthly prices of Lima (Ohio) and Indiana crude petroleum, per barrel of 42 gallons each, in the years 1898 and 1899:

Average monthly prices of Ohio and Indiana crude petroleum, per barrel of 42 gallons, in 1898 and 1899.

Month.	1898.			1899.		
	North Lima.	South Lima.	Indiana.	North Lima.	South Lima.	Indiana.
January	$0.46	$0.41	$0.41	$0.80	$0.75	$0.75
February	.47¼	.42¼	.42¼	.80	.75	.75
March	.57⅜	.52⅜	.52⅜	.79	.74	.74
April	.54¾	.49¾	.49¾	.79	.74	.74
May	.59⅛	.54⅛	.54⅛	.81⅜	.76⅜	.76⅜
June	.62⅛	.57⅛	.57⅛	.85⅛	.80⅛	.80⅛
July	.67⅝	.62⅝	.62⅝	.90⅜	.85⅜	.85⅜
August	.70⅝	.65⅝	.65⅝	.93⅜	.88⅜	.88⅜
September	.73	.68	.68	1.03¾	.98¾	.98¾
October	.76¼	.71¼	.71¼	1.07⅝	1.02⅝	1.02⅝
November	.77½	.72½	.72½	1.11¾	1.06¾	1.06¾
December	.78¾	.73¾	.73¾	1.16½	1.11½	1.11½
Average	.64¼	.59¼	.59¼	.92⅜	.87⅜	.87⅜
Average of North and South Lima.	.61¾		....	.89⅞		....

In the following table are given the fluctuations in prices for the various grades of Lima oil in 1899. The dates are those on which changes in prices were made.

Fluctuations in prices of Lima (Ohio) and Indiana crude petroleum in 1899.

Date.	North Lima.	South Lima.	Indiana.
January 1	$0.80	$0.75	$0.75
February 28	.79	.74	.74
May 16	.81	.76	.76
May 18	.83	.78	.78
May 24	.85	.80	.80
June 26	.86	.81	.81
June 30	.87	.82	.82
July 6	.88	.83	.83
July 11	.89	.84	.84
July 14	.91	.86	.86
July 18	.92	.87	.87
July 31	.93	.88	.88
August 29	.95	.90	.90
August 31	.98	.93	.93
September 2	.99	.94	.94
September 5	1.01	.96	.96
September 12	1.03	.98	.98
September 14	1.04	.99	.99
September 20	1.06	1.01	1.01
September 26	1.07	1.02	1.02
October 23	1.09	1.04	1.04
November 1	1.11	1.06	1.06
November 20	1.12	1.07	1.07
November 24	1.14	1.09	1.09
December 6	1.16	1.11	1.11
December 7	1.17	1.12	1.12

In the following tables will be found the highest, lowest, and average prices of Lima oil for the past thirteen years:

Highest, lowest, and average prices of Lima (Ohio) crude petroleum in each year from 1887 to 1899, inclusive.

Year.	Highest.	Lowest.	Average.
1887	\$0.15	\$0.15	\$0.15
1888	.15	.15	.15
1889	.15	.15	.15
1890	.37½	.15	.30
1891	.35	.30	.30½
1892	.37½	.35	.36⅝
1893	*a* .49	*b* .40	.47¼
1894	*a* .55	*b* .47½	.48
1895	*a* 1.27	*b* .50	.71¾
1896	*a* .90	*b* .52	.66¾
1897	*a* .60	*b* .41	.48
1898	*a* .80	*b* .41	.61¾
1899	*a* 1.17	*b* .74	.89⅞

a North Lima. *b* South Lima.

EASTERN OR SOUTHEASTERN OHIO DISTRICT.

This district includes all of eastern and southeastern Ohio, producing what is known as "Pennsylvania oil," and forming a part of the great Appalachian oil basin that extends from New York down through Pennsylvania, Ohio, and West Virginia into Kentucky and Tennessee. The principal subdivisions of this district are known as the Macksburg, Marietta, Corning, Steubenville, Scio, Newcastle, and Barnesville pools. A large portion of the Sistersville pool likewise is situated along the Ohio River, in the southeastern part of the State.

The other States that make up the Appalachian field have been fully discussed in the preceding pages.

PRODUCTION.

The production of the southeastern Ohio district for the last fifteen years is given in the following table:

Production of petroleum in the southeastern Ohio district from 1885 to 1899.

Year.	Barrels.	Year.	Barrels.
1885	661,580	1893	2,601,394
1886	703,945	1894	3,183,370
1887	372,257	1895	3,693,248
1888	297,774	1896	3,365,365
1889	317,037	1897	2,877,193
1890	1,108,334	1898	2,147,610
1891	422,883	1899	4,764,135
1892	1,190,302		

The past year's production of this district was the greatest on record. It shows an increase of 2,616,525 barrels, and was more than double that of 1898. There was a decrease of 729,583 barrels for 1898 as compared with 1897, and of 488,172 barrels for 1897 as compared with 1896. Prior to 1891 most of the production of southeastern Ohio came from the old Macksburg district.

The total value of 4,764,135 barrels of petroleum produced in the southeastern Ohio district in 1899 was $6,243,075, the average price being $1.31. Of this total product, 1,589,500 barrels were produced in the Scio field, which, at the average value per barrel of $1.34⅜, would be worth $2,135,891. The remaining product, 3,174,635 barrels, has been calculated at the average price received for Pennsylvania crude, which was $1.29⅜ per barrel in 1899, making the total value $4,107,184. In the following table is given a statement of production and value of petroleum in the southeastern Ohio district:

Production and value of petroleum in the southeastern Ohio district in 1899.

Pools.	Production.	Total value.	Average price per barrel.
	Barrels.		
Scio pool	1,589,500	$2,135,891	$1.34⅜
Macksburg, Marietta, and other pools.	3,174,635	4,107,184	1.29⅜
Total	4,764,135	6,243,075	1.31

The following table shows the total production of crude petroleum in Southeastern Ohio, by months, beginning with the year 1888 and ending with 1899:

Total production of crude petroleum in the Southeastern Ohio district from 1888 to 1899, by months.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.	June.	July.
1888..	20,144	25,327	23,515	23,720	25,837	24,426	31,535
1889..	24,855	23,218	26,382	24,708	24,961	24,011	22,619
1890..	36,713	40,712	53,193	60,729	80,167	98,268	118,182
1891..	89,061	40,620	28,297	29,361	28,935	25,014	30,571
1892..	33,762	32,894	42,371	45,439	50,407	55,930	69,678
1893..	189,874	209,948	238,133	217,001	204,151	206,106	213,431
1894..	209,225	213,721	253,979	268,736	283,371	273,876	267,144
1895..	251,865	223,140	276,422	285,314	285,436	290,763	305,222
1896..	321,895	281,776	293,538	291,358	286,669	278,634	274,317
1897..	293,801	262,035	266,343	255,213	266,760	259,100	245,876
1898..	179,371	165,313	182,591	179,779	181,666	176,993	163,448
1899..	217,322	249,493	359,144	365,345	417,869	423,801	470,829
Year.	**August.**	**September.**	**October.**	**November.**	**December.**	**Total.**	
1888..	23,537	22,945	25,442	25,831	25,515	297,774	
1889..	24,752	22,807	28,384	32,867	37,473	317,037	
1890..	132,173	140,634	138,224	113,664	95,675	1,108,334	
1891..	28,828	31,591	27,536	28,428	34,641	422,883	
1892..	111,377	151,543	206,005	188,391	202,505	1,190,302	
1893..	221,865	220,589	242,353	222,428	215,515	2,601,394	
1894..	275,360	278,704	303,441	278,162	277,651	3,183,370	
1895..	337,206	377,785	383,489	345,402	331,204	3,693,248	
1896..	270,135	255,326	270,752	251,367	289,598	3,365,365	
1897..	227,013	217,018	203,127	183,683	197,224	2,877,193	
1898..	181,555	175,779	180,001	180,615	200,499	2,147,610	
1899..	477,699	449,979	466,876	438,811	426,967	4,764,135	

PIPE-LINE RUNS IN THE SOUTHEASTERN OHIO DISTRICT.

In the following tables the pipe-line runs and the shipments from the Macksburg or Southeastern Ohio district are given from 1885 to 1899:

Pipe-line runs in the Southeastern Ohio district from 1885 to 1899.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.	June.	July.
1885..	11,894	20,626	27,066	40,527	58,258	64,982	75,737
1886..	54,806	46,694	58,795	64,137	58,596	65,379	56,966
1887..	37,134	28,514	33,995	29,796	30,601	29,586	22,413
1888..	16,257	18,861	17,283	21,187	22,227	21,511	21,785
1889..	18,174	16,239	19,676	20,144	20,283	18,536	16,705
1890..	29,872	34,022	45,362	53,905	72,158	90,827	111,584
1891..	86,058	45,618	23,055	25,070	24,263	21,689	24,858
1892..	24,801	27,620	39,010	40,424	43,569	50,007	64,107
1893..	183,781	211,658	235,177	211,102	199,929	146,626	148,622
1894..	138,172	121,627	150,095	190,677	239,912	228,267	221,999
1895..	94,999	181,155	220,883	229,159	225,816	227,643	251,003
1896..	321,468	272,933	296,565	294,603	279,317	283,385	267,797
1897..	289 720	263,896	284,298	255,715	266,687	257,925	242,160
1898..	175,546	164,419	184,451	182,567	185,388	174,768	161,163
1899..	214,365	236,365	327,232	384,749	403,361	414,366	457,512

Year.	August.	September.	October.	November.	December.	Total.	Average per month.
1885..	74,228	68,110	63,619	60,926	61,113	627,086	52,257
1886..	57,492	48,918	46,937	41,359	40,578	640,657	53,388
1887..	26,659	22,903	20,458	19,902	17,079	319,040	26,587
1888..	18,558	22,058	18,809	20,802	20,950	240,288	20,024
1889..	16,607	16,875	21,555	25,415	28,567	238,776	19,898
1890..	121,349	138,310	129,717	106,552	87,955	1,021,613	85,134
1891..	24,432	27,006	23,428	23,073	28,682	377,232	31,436
1892..	106,082	135,353	212,470	176,852	196,852	1,117,147	93,096
1893..	152,912	156,124	149,773	134,923	144,488	2,075,115	172,926
1894..	249,472	202,364	220,557	199,787	199,774	2,362,703	196,892
1895..	279,602	310,400	322,439	286,932	324,447	2,954,478	246,207
1896..	270,280	252,351	267,337	253,909	278,231	3,338,176	278,181
1897..	232,208	214,283	202,847	190,028	194,168	2,893,935	241,161
1898..	184,659	171,760	175,956	179,490	197,904	2,138,071	178,173
1899..	467,196	438,444	450,826	431,723	402,626	4,628,765	385,730

SHIPMENTS OF PETROLEUM FROM THE SOUTHEASTERN OHIO DISTRICT.

Shipments of crude petroleum and refined petroleum reduced to crude equivalent from the Southeastern Ohio district from 1886 to 1899.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.	June.	July.
1886..	60, 119	42, 525	32, 277	23, 578	28, 986	40, 211	28, 832
1887..	52, 065	23, 908	17, 593	16, 558	16, 002	17, 384	16, 504
1888..	40, 076	30, 045	4, 122	14, 920	15, 275	15, 630	9, 083
1889..	11, 847	16, 168	23, 939	8, 611	9, 027	8, 934	15, 269
1890..	44, 306	38, 898	35, 041	30, 975	13, 070	22, 851	46, 394
1891..	54, 363	27, 160	1, 040	2, 094	1, 060	41, 725	820
1892..	2, 594	2, 200	1, 763	1, 600	252	37, 989	1, 834
1893..	7, 174	6, 556	8, 218	5, 906	2, 338	1, 123	1, 025
1894..	3, 366	3, 932	2, 874	2, 272	1, 998	959	2, 569
1895..	4, 370	3, 106	3, 154	1, 130	869	1, 756	583
1896..	4, 128	3, 116	1, 874	1, 309	1, 026	300	0
1897..	2, 948	2, 437	2, 063	2, 776	400	1, 645	0
1898..	102	43	101	52	0	56	54
1899..	93	40	51	47	17	53	23

Year.	August.	September.	October.	November.	December.	Total.	Average per month.
1886..	45, 882	47, 992	53, 156	51, 608	49, 260	504, 426	42, 036
1887..	27, 719	35, 030	37, 978	34, 508	39, 654	334, 903	27, 909
1888..	6, 989	32, 698	47, 572	47, 066	26, 940	290, 416	24, 201
1889..	14, 507	22, 669	50, 447	47, 924	47, 090	276, 432	23, 036
1890..	107, 175	73, 469	57, 780	54, 540	53, 704	578, 203	48, 184
1891..	2, 318	3, 283	3, 040	2, 700	2, 236	141, 839	11, 820
1892..	1, 555	2, 102	3, 773	4, 358	6, 443	66, 463	5, 539
1893..	586	1, 964	2, 524	4, 538	2, 563	44, 515	3, 710
1894..	2, 309	3, 839	4, 377	4, 264	3, 999	36, 758	3, 063
1895..	1, 874	2, 124	4, 177	6, 716	3, 332	33, 191	2, 766
1896..	235	599	3, 641	2, 560	2, 561	21, 349	1, 779
1897..	1, 416	2, 323	3, 496	3, 510	55	23, 069	1, 922
1898..	47	48	106	58	51	718	60
1899..	367	38	0	0	0	729	61

The above table includes only the petroleum delivered to refineries at Parkersburg and Marietta by the Macksburg division of the Buckeye Pipe Line Company. The remaining shipments by this company were delivered to the trunk lines conveying oil to the seaboard, and are included in their monthly statements.

STOCKS OF CRUDE PETROLEUM IN THE SOUTHEASTERN OHIO DISTRICT.

Total stocks of crude petroleum in the southeastern Ohio district at the close of each month from 1886 to 1899, by months and years.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.	June.	July.
1886..	324, 483	332, 322	362, 923	407, 212	440, 329	467, 599	468, 796
1887..	404, 315	408, 926	425, 325	438, 562	453, 162	465, 363	472, 273
1888..	380, 551	386, 293	400, 602	407, 086	413, 858	420, 631	434, 573
1889..	363, 620	357, 527	360, 121	364, 796	376, 052	397, 718	387, 089
1890..	296, 413	291, 536	301, 856	324, 786	388, 874	451, 851	517, 042
1891..	685, 120	503, 284	480, 618	480, 364	453, 809	433, 773	401, 358
1892..	461, 616	468, 861	460, 750	462, 383	475, 768	447, 685	457, 176
1893..	410, 715	418, 513	397, 127	404, 951	407, 715	421, 222	413, 935
1894..	390, 977	388, 341	379, 037	376, 883	325, 664	294, 427	271, 801
1895..	172, 461	193, 935	236, 022	242, 317	204, 030	211, 740	184, 784
1896..	246, 557	290, 225	345, 405	348, 997	324, 443	248, 799	220, 759
1897..	485, 986	507, 619	522, 985	537, 636	515, 716	523, 944	519, 334
1898..	438, 224	445, 137	476, 064	476, 652	486, 206	446, 456	613, 303
1899..	573, 708	594, 610	586, 601	610, 417	647, 104	633, 131	714, 941

Year.	August.	September.	October.	November.	December.	Average.
1886..	456, 621	461, 842	437, 299	427, 950	419, 248	417, 219
1887..	471, 214	459, 085	441, 563	426, 957	404, 382	439, 261
1888..	444, 006	427, 797	394, 807	365, 873	351, 128	402, 267
1889..	389, 189	383, 393	354, 498	331, 939	310, 848	364, 732
1890..	531, 215	596, 056	660, 573	703, 031	698, 129	480, 113
1891..	378, 857	388, 855	431, 450	461, 037	454, 232	462, 730
1892..	462, 306	441, 494	434, 560	432, 283	422, 142	452, 252
1893..	426, 552	443, 669	458, 692	446, 503	415, 900	422, 124
1894..	241, 439	197, 660	179, 867	152, 200	147, 318	278, 801
1895..	182, 209	169, 850	192, 060	211, 591	231, 048	202, 671
1896..	214, 159	217, 946	434, 786	469, 580	465, 953	318, 967
1897..	541, 300	516, 498	496, 550	456, 413	436, 844	505, 069
1898..	568, 233	524, 403	520, 388	638, 755	556, 059	515, 823
1899..	693, 433	695, 478	667, 592	654, 441	674, 583	645, 503

THE SCIO OIL POOL.

The development of the Scio pool in Harrison County proved the most interesting feature of the year in southeastern Ohio, and attracted greater attention than any other district. Deep drilling was not required to reach the oil-bearing rock; the wells were of fair caliber and possessed wonderful staying powers. Within a little more than a year over 850 wells had been drilled and an oil production of over 1,600,000 barrels was recorded.

The first successful well was struck on June 15, 1898. Developments proceeded slowly until the beginning of 1899, when operators began flocking to the new field from all sections of the producing region. At the close of February there were 150 rigs and drilling wells under way in the Scio pool, and the staid old college town had become a hustling, bustling, oil-region city. In March, 1899, 126 wells were completed and the new production amounted to 3,850 barrels. Before the year was half gone the field had been pretty thoroughly defined, and operations were reduced to routine work on interior locations. A large number of wells were drilled on village lots within the borders of the town. Most of them proved profitable producers, although they did not last very long. By the end of the year many of them had been pulled out and abandoned and the rigs and machinery moved to other locations. At the close of 1899 only 10 rigs and 7 wells drilling were under way, and these were along the edges of the pool. No more 50-barrel strikes were forthcoming, and the average of the new wells had fallen to 5 or 10 barrels a day. For regularity of formation and the small number of dry holes no other pool in the Eastern fields surpassed and few have equaled that of Scio.

The story of the rise and development of the Scio oil pool is fully set forth in the tables that follow:

Well record in the Scio (Ohio) district in 1899.

Month.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	36	1,840	1	55	50
February	85	4,018	3	97	53
March	126	3,850	8	33	40
April	100	2,775	2	54	47
May	104	2,496	5	39	49
June	93	1,352	8	27	24
July	76	1,353	0	24	27
August	62	933	0	30	25
September	59	749	0	19	12
October	47	583	2	10	13
November	30	460	0	16	10
December	24	300	0	7	10
Total	842	a1,726	29	a34	a30

a Average.

Pipe line runs in the Scio, Ohio, oil field in 1899.

[Barrels of 42 gallons.]

Month.	Quantity.		Month.	Quantity.	
	Total.	Daily Average.		Total.	Daily Average.
January	30, 162	973	August	162, 622	5, 246
February	73, 909	2, 640	September....	149, 360	4, 979
March.........	115, 621	3, 730	October	142, 097	4, 584
April..........	166, 184	5, 539	November	128, 972	4, 299
May	171, 489	5, 532	December	114, 393	3, 690
June	167, 097	5, 570	Total ...	1, 589, 500	4, 355
July	167, 594	5, 406			

In addition to the above pipe-line runs a considerable quantity of oil was shipped from the Scio pool by tank cars, of which no figures were published. About 100,000 barrels were shipped by rail in this manner between May and December. This amount, added to the pipe-line runs, would make the total production of the Scio pool for 1899 about 1,689,500 barrels, or a daily average for the entire year of 4,600 barrels.

WELL RECORDS OF THE SOUTHEASTERN OHIO DISTRICT.

The following tables show the wells completed, number of dry holes, new production, and rigs and drilling wells under way from month to month in the various districts of southeastern Ohio. They are incomplete for the reason that a considerable portion of the operations are included with the Sistersville division of the southwest district. The Sistersville field in West Virginia extends across the Ohio and covers a considerable area on the Ohio side of the river. It is impossible to separate the operations in the two States, as no attempt has been made to keep distinct records. Probably a third of the wells in the Sistersville section are located in southeastern Ohio.

Total number of wells completed in the Southeastern Ohio district in 1899.

Month.	Corning.	Macksburg.	Marietta.	Scio.	Jewett.	Wellsville.	Cadiz.	Total.
January	7	5	34	36	2	0	0	84
February	2	4	32	85	0	0	0	123
March	3	5	28	126	4	0	0	166
April	5	6	55	100	5	0	0	171
May	9	6	42	104	6	0	0	167
June	5	11	64	93	8	0	0	181
July	11	12	63	77	7	0	0	170
August	11	9	59	62	7	0	0	148
September	5	8	62	59	8	0	0	142
October	6	13	80	47	8	1	0	155
November	4	26	66	30	2	8	7	143
December	9	23	67	24	3	9	11	146
Total	77	128	652	843	60	18	18	1,796

Wells completed in Southeastern Ohio district, 1891 to 1899.

Field.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Corning	......	......	127	92	197	239	87	42	77
Jewett	......	......	......	......	......	......	......	......	60
Macksburg	14	55	47	103	80	185	188	92	128
Marietta	5	10	4	5	102	95	70	133	652
Scio	......	......	......	......	......	......	......	*a* 14	843
Steubenville	......	......	......	6	62	25	83	29	0
Miscellaneous	8	21	12	9	19	75	70	56	36
Total	27	86	190	215	460	619	498	366	1,796

a Includes Jewett.

Number of wells completed in the Southeastern Ohio district from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	10	8	27
1892	7	9	12	7	14	8	5	2	4	2	14	2	86
1893	10	15	13	19	24	15	26	18	21	15	7	7	190
1894	9	6	15	17	17	21	23	18	19	21	22	27	215
1895	25	17	31	37	57	56	50	48	40	41	25	33	460
1896	43	41	43	45	71	49	66	51	50	43	60	57	619
1897	55	30	46	58	63	51	35	44	34	29	22	31	498
1898	21	18	18	27	28	21	26	24	41	43	41	58	366
1899	84	123	166	171	167	181	170	148	142	155	143	146	1,796

Initial daily production of wells completed in the Southeastern Ohio district in 1899.

[Barrels of 42 gallons.]

Month.	Corning.	Macks-burg.	Marietta.	Scio.	Jewett.	Wells-ville.	Cadiz.	Total.
January	42	0	308	1,840	6	0	0	2,196
February	10	18	277	4,018	0	0	0	4,323
March	40	15	311	3,850	3	0	0	4,219
April	75	41	685	2,775	0	0	0	3,576
May	85	15	620	2,496	0	0	0	3,216
June	40	57	631	1,352	5	0	0	2,085
July	170	90	916	1,353	18	0	0	2,547
August	128	22	1,475	933	17	0	0	2,575
September	30	53	860	749	83	0	0	1,775
October	38	218	851	583	120	40	0	1,850
November	13	245	887	460	0	98	21	1,724
December	42	123	586	300	9	10	262	1,332
Average	59	75	700	1,726	22	12	24	2,618

Initial daily production of wells completed in Southeastern Ohio district from 1891 to 1899.

[Barrels of 42 gallons.]

Field.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Corning	......	......	162	126	206	179	40	19	59
Jewett	......	......	......	......	......	......	......	......	22
Macksburg	39	52	48	70	36	118	96	36	75
Marietta	9	3	3	22	91	90	74	183	700
Scio	......	......	......	......	......	......	......	a 32	1,726
Steubenville	......	......	......	5	97	15	42	6	0
Miscellaneous	76	42	5	2	15	79	53	63	36
Total	124	97	218	225	445	481	305	339	2,618

a Includes Jewett.

Initial daily production of new wells in the Southeastern Ohio district from 1891 to 1899, by months.

[Barrels of 42 gallons.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	.....	.....	.....	.....	.....	.....	.....	.....	.....	36	265	70	124
1892	60	152	393	65	291	25	43	2	0	20	117	0	97
1893	209	168	109	254	350	210	323	398	240	234	37	78	218
1894	143	50	74	172	246	223	262	232	180	468	215	433	225
1895	387	348	680	506	748	465	528	406	398	269	284	317	445
1896	338	359	787	413	554	426	473	300	434	594	592	498	481
1897	499	302	433	361	374	287	158	465	240	170	192	182	305
1898	157	49	74	68	192	142	216	173	392	494	748	1,362	339
1899	2,196	4,323	4,219	3,576	3,216	2,085	2,547	2,575	1,775	1,850	1,724	1,332	2,618

Total number of dry holes drilled in the Southeastern Ohio district in 1899.

Month.	Corning.	Macksburg.	Marietta.	Scio.	Jewett.	Wellsville.	Cadiz.	Total.
January	3	5	20	1	1	0	0	30
February	0	1	10	3	0	0	0	14
March	0	3	12	8	3	0	0	26
April	2	3	14	2	5	0	0	26
May	2	3	13	5	6	0	0	29
June	1	5	22	8	7	0	0	43
July	0	3	31	0	4	0	0	38
August	3	5	21	0	4	0	0	33
September	3	1	20	0	2	0	0	26
October	2	2	25	2	4	0	0	35
November	2	11	20	0	2	3	3	41
December	5	10	22	0	1	6	6	50
Total	23	52	230	29	39	9	9	391

Dry holes drilled in the Southeastern Ohio district from 1891 to 1899.

Field.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899
Corning	......	......	21	12	27	33	18	24	23
Jewett	......	......	......	......	......	......	......	0	39
Macksburg	8	24	16	65	33	67	86	55	52
Marietta	2	5	1	......	36	51	37	47	230
Scio	......	......	......	......	......	......	......	0	29
Steubenville	......	......	......	2	20	9	28	17	0
Miscellaneous	4	7	8	6	9	40	27	17	18
Total	14	36	46	85	125	200	196	160	391

Total number of dry holes drilled in the Southeastern Ohio district from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct	Nov.	Dec.	Total.
1891										5	5	4	14
1892	2	3	4	4	4	5	1	2	4	1	4	2	36
1893	0	2	4	3	8	2	7	3	7	4	4	2	46
1894	3	2	8	7	5	9	8	8	7	8	11	9	85
1895	11	3	6	9	9	18	11	14	7	20	5	12	125
1896	11	15	9	16	31	11	23	19	12	13	24	16	200
1897	20	10	11	20	26	25	14	22	14	9	12	13	196
1898	12	10	10	16	16	8	13	10	18	11	15	21	160
1899	30	14	26	26	29	43	38	33	26	35	41	50	391

Total number of wells drilling in the Southeastern Ohio district in 1899.

Month.	Corning.	Macksburg.	Marietta.	Scio.	Jewett.	Wellsville.	Cadiz.	Total.
January	3	8	21	55	0	0	0	87
February	5	10	24	97	3	0	0	139
March	4	10	20	33	5	0	0	72
April	2	10	16	54	2	0	0	84
May	5	9	17	39	2	0	0	72
June	5	15	25	27	3	0	0	75
July	4	11	30	24	7	0	0	76
August	0	9	41	30	5	0	0	85
September	7	8	31	19	8	0	0	73
October	2	20	26	10	9	5	0	72
November	4	14	28	16	6	5	11	84
December	2	11	34	7	4	1	4	63
Average	4	11	26	34	5	1	1	82

Average number of wells drilling in Southeastern Ohio district from 1891 to 1899.

Field.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Corning			7	5	8	11	2	2	4
Jewett									5
Macksburg	2	5	4	8	9	11	10	6	11
Marietta	5	2			6	4	2	6	26
Scio								*a* 2	34
Steubenville				1	4	1	3	1	0
Miscellaneous	6	3	2	1	3	7	5	3	2
Total	13	10	13	15	30	34	22	20	82

a Includes Jewett.

Number of wells drilling in the Southeastern Ohio district at the close of each month from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	14	10	13
1892	15	15	12	9	14	9	6	6	6	10	7	9	10
1893	14	10	15	15	13	15	13	19	12	8	9	12	13
1894	11	4	19	5	17	15	18	18	16	15	19	22	15
1895	19	21	16	34	32	38	35	41	35	27	33	33	30
1896	33	22	38	42	27	36	35	26	33	35	40	36	34
1897	19	27	31	22	21	26	22	25	18	15	21	15	22
1898	11	7	11	12	10	15	13	20	21	30	35	60	20
1899	87	139	72	84	72	75	76	85	73	72	84	63	82

Total number of rigs building in the Southeastern Ohio district in 1899.

Month.	Corning.	Macksburg.	Marietta.	Scio.	Jewett.	Wellsville.	Cadiz.	Total.
January	2	8	26	50	2	0	0	88
February	1	6	21	53	3	0	0	84
March	3	7	18	40	1	0	0	69
April	2	6	14	47	1	0	0	70
May	6	9	22	49	0	0	0	86
June	3	7	30	24	5	0	0	69
July	3	5	34	27	3	0	0	72
August	5	6	26	25	0	0	0	62
September	4	6	34	12	6	0	0	62
October	4	12	47	13	2	3	0	81
November	6	9	40	10	1	2	8	76
December	1	6	38	10	2	1	7	65
Average	4	7	29	30	2	1	1	74

Number rigs building in the Southeastern Ohio district from 1891 to 1899.

Field.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Corning	.....	.....	6	8	12	9	4	2	4
Jewett	.....	.....	.....	.....	.....	.....	.....	.....	2
Macksburg	4	8	4	6	6	9	10	3	7
Marietta	7	3	1	.....	3	4	1	7	29
Scio	.....	.....	.....	.....	.....	.....	.....	*a* 2	30
Steubenville	.....	.....	.....	.....	4	1	2	1	0
Miscellaneous	4	3	1	1	1	2	2	2	2
Average	15	14	12	15	26	25	19	17	74

a Includes Jewett.

Rigs building in the Southeastern Ohio district from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	20	4	15
1892	18	17	14	13	21	10	8	11	13	16	13	13	14
1893	16	17	23	11	4	9	12	9	13	9	13	13	12
1894	9	13	13	9	13	13	18	18	15	27	19	17	15
1895	16	23	21	26	24	28	25	30	24	24	38	31	26
1896	38	24	24	30	22	21	23	26	22	30	22	22	25
1897	25	23	24	25	21	16	18	15	11	19	19	10	19
1898	9	8	11	10	14	9	17	10	12	20	25	63	17
1899	88	84	69	70	86	69	72	62	62	81	76	65	74

The following table shows the wells completed, the initial production, the dry holes, wells drilling, and rigs building in the southeastern Ohio oil field in 1899:

Well record in the Southeastern Ohio district in 1899.

Month.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	84	2,196	30	87	88
February	123	4,323	14	139	84
March	166	4,219	26	72	69
April	171	3,576	26	84	70
May	167	3,216	29	72	86
June	181	2,085	43	75	69
July	170	2,547	38	76	72
August	148	2,575	33	85	62
September	142	1,775	26	73	62
October	155	1,850	35	72	81
November	143	1,724	41	84	76
December	146	1,332	50	63	65
Total	1,796	*a* 2,618	391	*a* 82	*a* 74

a Average.

MECCA-BELDEN DISTRICT.

The product of these two fields is used only for lubricating purposes. The oil is black, 28° gravity, with a cold test of about 15° above zero. The wells are not pumped with any regularity, owing to their small production and the presence of a large amount of water. The fields are isolated by many miles from other oil developments and are themselves widely separated. They yield a very fine article of natural lubricating oil, which comes from the Berea sandstone. The Mecca district is near Warren, Ohio, in the northern part of Trumbull County, and

the Belden district is in Lorain County, just south of Elyria. The production increased 117 barrels the past year, and the price has advanced from an average of $4.35 a barrel in 1896 to $4.84 in 1897, $5.30½ in 1898, and $5.31 in 1899.

PRODUCTION.

The following table gives the production of crude petroleum in the Mecca-Belden district in 1899:

Production of crude petroleum in the Mecca-Belden district in 1899.

District.	Barrels of 42 gallons.	Value.	Price per barrel.
Belden, Lorain County	610	$2,298	$3.77
Mecca, Trumbull County	189	1,946	10.295
Total	799	4,244	5.31

In the following tables are given the production and value and stocks of the crude petroleum in this district from 1892 to 1899:

Production and value of crude petroleum in the Mecca-Belden district of Ohio from 1892 to 1899.

Year.	Belden district, Lorain County.			Mecca district, Trumbull County.			Total.		
	Production.	Value.	Value per barrel.	Production.	Value.	Value per barrel.	Production.	Value.	Value per barrel.
	Barrels.			*Barrels.*			*Barrels.*		
1892	1,732	$9,280	$5.36	1,380	$11,821	$8.57	3,112	$21,101	$6.78
1893	1,120	8,014	7.15	451	3,321	7.36	1,571	11,335	7.21½
1894	740	3,276	4.43	200	1,200	6.00	940	4,476	4.76
1895	833	4,200	5.04	543	4,029	7.42	1,376	8,229	5.98
1896	520	1,848	3.55	146	1,049	7.18	666	2,897	4.35
1897	500	1,972	3.94	145	1,148	7.91½	645	3,120	4.84
1898	510	1,879	3.68	172	1,739	10.11	682	3,618	5.30½
1899	610	2,298	3.77	189	1,946	10.29½	799	4,244	5.31

STOCKS OF PETROLEUM IN THE MECCA-BELDEN DISTRICT, OHIO.

Stocks at wells in the Mecca-Belden district of Ohio.

Year ending Dec. 31—	Barrels.	Year ending Dec. 31—	Barrels.
1891	4,048	1896	70
1892	161	1897	69
1893	403	1898	225
1894	225	1899	310
1895	390		

In February, 1899, drilling was begun in the old Belden developments and a new pool of heavy lubricating oil, which promises to be much more productive than the original field or pool, was discovered. About fourteen wells were drilled, only two of which were nonproductive. None of the wells were pumped in 1899, but will be operated in 1900. This new pool lies about 1½ miles east of the original developments and extends for a distance of about 3 miles north and south with a width of about 1½ miles.

While drilling 1 mile south of this new pool above referred to, a light petroleum of 42° Baumé was discovered in the same sand, the Berea grit. It was found lying about 100 feet deeper than in the heavy oil district. In the Berea formation, from which the heavy oil is produced, there is usually a large amount of salt water accompanying the oil, with very little gas, while in the section where the light oil was found there is very little salt water with quite a large amount of gas. In this light oil district there seem to be two distinct pools, one beginning about 2½ miles southeast of the town of Belden, extending in a southeasterly direction, the southern end being at the town of Erhart. Three miles east from Erhart is another pool of about the same dimensions. No large producing wells have so far been found in these new light oil pools, but the petroleum is of excellent quality, entirely free from sulphur and similar to the Pennsylvania crude. In the heavy oil field the Berea sand is found at a depth of from 150 to 250 feet, while at Erhart the sand is at an average depth of 350 feet. These discoveries have resulted in considerable drilling in every direction, except west, from the old Belden field.

A new field of lubricating oil is being opened up at Lodi, in Medina County, about 12 miles south and a little west of Erhart. During the latter part of 1899 some drilling was done and oil found at a depth of 400 feet. The oil is from 36° to 38° B. None of the wells were pumped in 1899. The oil comes from the Berea grit sand rock.

INDIANA.

Indiana made a small gain in production during 1899 and completed more wells than in any previous year since 1896. The price of Indiana oil was the highest known in the history of the field, so that the total value exceeded that of any preceding year.

The total production of Indiana for 1899, was 3,848,182 barrels, which was valued at $3,363,738. This was an increase over 1898 of 117,275 barrels, or a little over 3 per cent, while there was a gain of $1,149,416, or nearly 52 per cent in value. The Indiana production for 1898 was 3,730,907 barrels, valued at $2,214,322. Comparing 1899 with 1897, there was a decrease of 6½ per cent in production accompanied by a gain of 79 per cent in value. The price, which

declined from 63 cents per barrel in 1896 to 45.6 cents in 1897, advanced to 59.4 cents in 1898 and to 87.4 cents in 1899.

Indiana's oil field is merely an extension to the southwest of the Trenton rock territory of northwestern Ohio. It has proved highly productive both in oil and gas. A large amount of this territory is now devoted exclusively to gas production owing to legal restrictions against the shutting in of gas wells. This will be developed into oil-producing territory when the restrictions are removed, which will be brought about by a lessening of the gas pressure.

The largest strike of the year in the Indiana field was located on the Storms farm in Washington Township, Blackford County. The well was completed in January, and made a surprising start of 500 or 600 barrels a day. It resulted in considerable new work in that vicinity, but nothing large was opened up. Four miles northeast of Peru another good well was found, but anticipations of a new pool were not realized. A small extension of the Van Buren district was discovered in April, which added some new territory along its western border.

A small district along the State line attracted some attention in August, and furnished the first real excitement of the year. A test well on the Gillespie farm in Blue Creek Township, Adams County, made a good showing, but contained a large amount of salt water. It did not make a large producer, but proved the incentive for a rush of new operations. A number of dry holes were drilled in the attempt to locate the streak supposed to connect the Ohio and Indiana fields, but apart from a small pool opened up by the Ohio Oil Company on the Dudgeon and several adjoining farms nothing of any great importance was brought to light. The district never maintained an average daily output of 100 barrels. The first well on the Dudgeon farm started at 60 barrels a day.

In October a small strike, drilled by a local company near Loogootee, in Martin County, in the southern part of the State, caused a stampede among oil leasers and operators. The well was quite a strong gasser, and flowed 10 barrels at the start, the oil being found in a sand formation at a depth of 500 feet. Several dry holes were drilled in this vicinity, and at the close of the year there was nothing to indicate an oil development of any large area.

In the Alexandria gas district there are a number of oil wells shut down by order of the courts, in accordance with the laws against gas waste. These will be opened up when the gas pressure goes down naturally, or when sale for the gas is obtained, but the probabilities of a large amount of new production from this source are exceedingly remote. Some of the wells which were tested, after being shut in for two years, were found to be filled with water, and several weeks' pumping failed to restore a flow of either oil or gas.

The advancing market during 1899 caused a large amount of drilling in Indiana, and there was a decided increase in the number of wells completed, but the results were behind the records established in 1894, 1895, and 1896. Of the 1,057 wells completed in Indiana during 1899, only 103, or about 10 per cent, were dry holes. This is a most remarkable feature, as during the early developments of the Trenton-rock oil fields this State acquired a reputation for the spotted character of its oil territory. Compared with 1898, Indiana showed an increase of 363 in the number of completed wells, which was a gain of 52.3 per cent. Only 9 more wells were completed in the Indiana fields in 1898 than in 1897. At the close of the year there were 54 rigs building and 100 wells drilling in the Indiana oil fields, which was an increase of 28 rigs and 36 wells over the figures for the last day of 1898.

PRODUCTION.

In the following table will be found a statement of the production of petroleum in Indiana from 1891 to 1899:

Production of petroleum in Indiana from 1891 to 1899.

	1891.	1892.	1893.	1894.	1895.
Total production (barrels of 42 gallons)	136, 634	698, 068	2, 335, 293	3, 688, 666	4, 386, 132
Total value at wells of all oils produced, excluding pipage	$54, 787	$260, 620	$1, 050, 882	$1, 774, 260	$2, 811, 444
Value per barrel	$0. 40	$0. 37	$0. 45	$0. 48	$0. 64

	1896.	1897.	1898.	1899.
Total production (barrels of 42 gallons)	4, 680, 732	4, 122, 356	3, 730, 907	3, 848, 182
Total value at wells of all oils produced, excluding pipage	$2, 954, 411	$1, 880, 412	$2, 214, 322	$3, 363, 738
Value per barrel	$0. 63	$0. 45$\frac{3}{5}$	$0. 59$\frac{2}{5}$	$0. 87$\frac{2}{5}$

The following is a very complete record of the monthly production, beginning in January, 1891, and closing with December, 1899. It also gives the average monthly production for the same period:

Total production of petroleum in Indiana from 1891 to 1899, by months.

[Barrels of 42 gallons.]

Year.	January.	February.	March.	April.	May.	June.	July.
1891 ...	6, 171	5, 981	5, 159	4, 973	5, 757	8, 136	10, 809
1892 ...	15, 841	18, 946	24, 794	26, 184	31, 033	40, 888	49, 203
1893 ...	111, 824	96, 025	134, 549	146, 493	186, 939	209, 616	221, 666
1894 ...	259, 000	232, 107	282, 376	287, 330	321, 502	333, 479	327, 349
1895 ...	300, 568	230, 559	310, 303	352, 077	397, 001	403, 569	434, 376
1896 ...	365, 582	341, 743	386, 586	395, 032	417, 963	434, 167	422, 968
1897 ...	315, 980	309, 867	347, 922	327, 744	346, 515	347, 884	351, 280
1898 ...	318, 254	273, 900	326, 540	311, 235	312, 448	321, 676	280, 101
1899 ...	306, 784	242, 980	307, 452	301, 782	331, 009	334, 779	340, 533
Year.	**August.**	**September.**	**October.**	**November.**	**December.**	**Total.**	**Average.**
1891 ...	11, 603	16, 500	19, 029	20, 801	21, 715	136, 634	11, 386
1892 ...	56, 109	66, 034	95, 699	129, 270	144, 067	698, 068	58, 172
1893 ...	248, 353	245, 615	252, 568	245, 607	236, 038	2, 335, 293	194, 608
1894 ...	345, 031	319, 588	339, 424	304, 030	337, 450	3, 688, 666	307, 389
1895 ...	420, 132	409, 169	393, 153	373, 789	361, 436	4, 386, 132	365, 511
1896 ...	407, 238	415, 675	394, 283	337, 331	362, 164	4, 680, 732	390, 061
1897 ...	345, 856	329, 379	372, 113	379, 896	347, 920	4, 122, 356	343, 530
1898 ...	334, 017	327, 465	320, 730	301, 843	302, 698	3, 730, 907	310, 909
1899 ...	344, 498	330, 631	344, 633	338, 782	324, 319	3, 848, 182	320, 682

WELL RECORDS IN THE INDIANA FIELDS.

There were 954 productive wells and 103 dry holes completed in the Indiana oil fields in 1899 as compared with 580 productive wells and 114 dry holes completed in 1898. While the productive wells were increased 374 during the year, the number of dry holes was 11 less than in 1898.

The productive wells completed in the Indiana fields in 1898 showed an increase of 24 and the dry holes a decrease of 16 as compared with the preceding year. While about 20 per cent of the wells drilled in 1897 were destitute of oil in paying quantities, only 16.4 per cent of the total drilled in 1898 and less than 10 per cent in 1899 were failures.

There were 686 wells completed in the Indiana oil fields in 1897, and 130 were dry holes. In 1896 the number of wells completed was 1,180, and 158 of them were dry holes. In the year 1895 there were completed 1,267 wells, which was the greatest number yet recorded. The dry holes amounted to 166.

Up to January 1, 1898, 5,267 wells had been drilled in the Indiana oil fields. The total at the close of the year was 5,961. Adding 1,057

for 1899 gives a total of 7,018 wells drilled in Indiana down to the close of that year. The number of producing wells at the beginning of 1898 was placed at 3,850. Adding the number of wells completed in 1898 and 1899 and deducting the dry holes and abandoned wells will give 4,968 as the number of producing wells for December 31, 1899. There were 169 wells abandoned in 1898 and 247 in 1899.

The following tables show the total number of wells completed, the initial daily production of the producing wells, the total number of dry holes, and the total number of wells drilling and rigs building in the Indiana oil fields for each month during 1899:

Total number of wells completed in Indiana in 1899, by counties.

Month.	Adams.	Blackford.	Grant.	Huntington.	Jay.	Wells.	Miami.	Marion.	Wabash.	Total.
January ...	2	16	16	2	6	27	4	2	0	75
February ..	2	10	8	2	4	15	2	2	3	48
March......	4	10	10	4	7	28	4	1	0	68
April.......	2	10	13	5	1	28	2	2	1	64
May	6	14	18	4	3	37	3	0	2	87
June	2	20	27	5	1	40	1	0	3	99
July	2	7	17	6	3	37	3	0	2	77
August	8	14	19	4	3	54	2	0	0	104
September.	7	14	25	4	7	46	2	1	0	106
October ...	4	26	15	3	10	57	0	2	1	118
November .	6	20	14	0	7	57	0	0	2	106
December .	6	14	19	6	9	47	2	1	1	105
Total.	51	175	201	45	61	473	25	11	15	1,057

Number of wells completed in Indiana from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Adams	2	70	88	119	110	111	42	37	51
Blackford	21	9	40	72	122	221	72	139	175
Grant	......	3	......	13	111	118	44	66	201
Huntington...	......	......	......	14	26	63	30	34	45
Jay	9	117	202	257	245	206	52	53	61
Marion	......	......	......	......	......	......	16	55	11
Miami........	......	......	......	......	......	......	178	35	25
Wabash	......	......	......	......	......	......	1	56	15
Wells	31	96	212	713	648	461	181	206	473
Miscellaneous.	2	......	......	1	5	......	70	13	0
Total...	65	295	542	1,189	1,267	1,180	686	694	1,057

In the following table is shown the number of wells completed in the Indiana petroleum fields from 1891 to 1899 inclusive, by months:

Number of wells completed in the Indiana oil fields from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891.	.....	.....	.....	.....	.....	.....	6	6	15	15	15	8	65
1892.	11	13	18	13	17	19	17	30	25	52	33	47	295
1893.	20	30	31	36	45	47	47	55	27	72	56	76	542
1894.	90	103	103	80	110	107	84	123	100	107	97	85	1,189
1895.	61	45	81	111	122	153	132	140	129	106	102	85	1,267
1896.	76	90	86	136	148	150	113	121	70	58	66	66	1,180
1897.	41	35	40	47	49	52	60	45	55	89	119	54	686
1898.	41	23	29	43	38	55	53	80	72	82	92	86	694
1899.	75	48	68	64	87	99	77	104	106	118	106	105	1,057

The following table shows the initial daily production of wells completed in Indiana during 1899, by months. As this is a fair index to the production in a regular way, it shows where the richest pools exist. The average initial daily production for 1898 was 1,197 barrels, and for 1897 it was 1,618, as compared with 1,744 in 1899:

Initial daily production of wells completed in Indiana in 1899, by counties and months.

[Barrels of 42 gallons.]

Month.	Adams.	Blackford.	Grant.	Huntington.	Jay.	Wells.	Miami.	Marion.	Wabash.	Total.
January ...	20	315	370	40	130	760	25	55	0	1,715
February ..	50	65	205	55	70	330	5	30	20	830
March	115	160	150	125	60	665	90	0	0	1,365
April	35	85	410	95	10	685	30	75	0	1,425
May	160	145	505	60	30	1,080	50	0	0	2,030
June	15	145	905	60	0	790	10	0	15	1,940
July	10	110	415	150	25	810	15	0	5	1,540
August	125	85	560	45	20	1,000	40	0	0	1,875
September.	75	115	730	170	25	855	5	10	0	1,985
October ...	25	195	490	40	190	975	0	90	5	2,010
November.	170	180	246	0	95	1,445	0	0	5	2,141
December.	85	235	385	160	180	985	30	5	5	2,070
Average.	74	153	448	83	69	865	25	22	5	1,744

Average initial daily production of wells in Indiana oil fields from 1891 to 1899, by counties.

[Barrels of 42 gallons.]

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Adams	4	198	358	363	279	233	75	74	74
Blackford	165	10	138	131	204	265	133	158	153
Grant	......	4	......	15	235	240	102	157	448
Huntington	......	......	......	21	29	118	78	66	83
Jay	27	789	1,537	696	508	303	62	67	69
Marion	......	......	......	......	......	......	39	140	22
Miami	......	......	......	......	......	......	682	39	25
Wabash	......	......	......	......	......	......	1	146	5
Wells	162	386	1,005	2,170	1,551	950	300	322	865
Miscellaneous	2	......	......	......	4	......	146	28	0
Total	360	1,387	3,038	3,396	2,810	2,109	1,618	1,197	1,744

Initial daily production of wells in Indiana oil fields from 1891 to 1899, by months.

[Barrels of 42 gallons.]

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	......	342	1,020	2,361	2,132	1,557	730	710	1,715
February	......	250	913	2,935	1,413	1,875	1,000	500	830
March	......	289	2,805	3,395	2,504	2,090	1,000	1,130	1,365
April	......	316	4,135	3,175	3,473	2,825	800	1,075	1,425
May	......	505	3,155	4,450	3,035	3,149	1,295	890	2,030
June	......	545	5,595	4,886	4,923	3,115	900	1,245	1,940
July	253	595	3,880	3,530	3,067	2,332	1,800	1,415	1,540
August	135	1,295	4,184	3,435	2,760	2,650	850	1,555	1,875
September	875	2,145	2,055	3,149	3,175	1,700	2,010	1,255	1,985
October	330	4,155	3,442	3,455	2,651	1,515	4,200	1,525	2,010
November	390	3,050	2,305	3,323	2,560	1,400	3,790	1,675	2,141
December	175	3,160	2,968	2,654	2,025	1.100	1,045	1,390	2,070
Average	360	1,387	3,038	3,396	2,810	2,109	1,618	1,197	1,744

The statistics of the dry holes drilled in Indiana are presented in the following tables:

Total number of dry holes drilled in Indiana in 1899, by counties.

Month.	Adams.	Blackford.	Grant.	Huntington.	Jay.	Wells.	Miami.	Marion.	Wabash.	Total.
January ...	0	0	1	0	0	1	3	0	0	5
February ..	0	4	2	0	1	1	1	0	0	9
March	0	3	4	1	2	2	1	1	0	14
April	0	2	0	1	0	0	1	0	1	5
May	0	1	0	0	1	0	1	0	2	5
June	0	1	1	0	1	3	0	0	1	7
July	1	2	1	1	1	3	2	0	1	12
August	1	4	0	0	2	2	0	0	0	9
September.	2	1	1	0	3	4	1	0	0	12
October ...	2	3	1	0	3	4	0	0	0	13
November .	1	3	0	0	1	2	0	0	1	8
December .	0	0	0	0	0	3	1	0	0	4
Total.	7	24	11	3	15	25	11	1	6	103

Number of dry holes drilled in Indiana from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Adams	1	12	28	20	12	14	13	4	7
Blackford	7	3	6	12	12	31	23	25	24
Grant	......	1	......	4	7	4	1	5	11
Huntington...	......	......	......	4	7	7	1	6	3
Jay	2	47	47	68	71	63	19	16	15
Marion	......	......	......	......	......	......	5	6	1
Miami........	......	......	......	......	......	......	12	17	11
Wabash	......	......	......	......	......	......	0	13	6
Wells	5	13	30	72	55	39	20	17	25
Miscellaneous.	......	......	......	1	2	......	36	5	0
Total...	15	76	111	181	166	158	130	114	103

Total number of dry holes drilled in Indiana oil fields from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891..	....	....	.....	.....	.....	.....	0	2	5	4	3	1	15
1892..	2	6	6	2	3	4	2	3	3	18	6	21	76
1893..	7	10	10	6	14	6	11	9	5	14	10	9	111
1894..	19	14	24	14	13	13	9	21	15	14	8	17	181
1895..	7	4	13	16	22	20	15	23	12	12	9	13	166
1896..	10	13	6	28	26	20	14	19	4	4	6	8	158
1897..	8	9	7	12	5	16	11	9	16	11	18	8	130
1898..	14	4	2	13	9	6	7	10	12	8	13	16	114
1899..	5	9	14	5	5	7	12	9	12	13	8	4	103

In the following tables are shown the statistics of wells drilling in Indiana, by months and counties, in 1899 and since 1891:

Total number of wells drilled in Indiana in 1899, by counties.

Month.	Adams.	Blackford.	Grant.	Huntington.	Jay.	Wells.	Miami.	Marion.	Wabash.	Total.
January ...	4	12	9	3	4	19	3	2	3	59
February ..	6	9	7	4	2	24	4	1	0	57
March......	4	8	9	4	1	23	2	0	1	52
April......	4	7	10	3	3	18	3	0	1	49
May	1	13	15	5	1	23	3	0	1	62
June	3	6	10	4	2	26	2	0	1	54
July	6	11	9	5	3	27	1	0	0	62
August	5	15	12	4	3	28	2	1	1	71
September .	2	14	15	2	8	43	3	1	0	88
October ...	3	14	9	3	4	34	4	1	0	72
November .	4	14	19	5	8	37	4	2	0	93
December .	4	19	16	8	8	38	4	2	1	100
Average .	4	12	12	4	4	28	3	1	1	69

Average number of wells drilling in Indiana from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Adams	1	3	5	5	7	7	2	3	4
Blackford	2	1	2	3	6	11	4	11	12
Grant	......	......	......	2	10	9	3	5	12
Huntington...	......	......	......	1	3	4	2	3	4
Jay	2	8	12	12	20	14	3	3	4
Marion	......	......	......	......	......	......	1	2	1
Miami........	......	......	......	......	......	......	6	3	3
Wabash	......	......	......	......	......	......	......	2	1
Wells	4	6	12	38	42	28	12	12	28
Miscellaneous.	......	......	......	......	......	......	3	4	0
Total...	9	18	31	61	88	73	36	48	69

Number of wells drilling in the Indiana oil fields at the close of each month from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891..	....	....	.....	.....	.....	.....	5	13	12	8	4	12	9
1892..	17	15	11	12	13	16	11	16	23	23	26	24	17
1893..	24	19	22	18	20	28	29	45	27	50	36	50	31
1894..	63	71	37	56	60	61	71	64	58	62	62	58	60
1895..	66	52	62	82	112	101	109	110	103	102	78	81	88
1896..	97	80	90	99	99	88	88	52	47	45	43	52	73
1897..	38	35	30	33	35	39	34	29	48	40	45	29	36
1898..	21	27	35	30	33	40	54	48	71	72	78	64	48
1899..	59	57	52	49	62	54	62	71	88	72	93	100	69

The total number of rigs or derricks building in each county by months in 1899 and since 1891 is shown in the following tables:

Total number of rigs or derricks building in Indiana in 1899, by counties and months.

Month.	Adams.	Black-ford.	Grant.	Hunt-ington.	Jay.	Wells.	Miami.	Marion.	Wa-bash.	Total.
January	1	3	3	3	3	14	0	0	0	27
February	0	4	3	3	3	12	0	0	0	25
March	1	2	7	4	2	6	1	1	0	24
April	0	8	4	1	2	8	0	0	0	23
May	0	6	5	2	2	16	1	0	1	33
June	2	4	7	5	3	8	0	0	0	29
July	3	0	2	1	2	9	1	0	0	18
August	0	7	2	2	3	7	1	0	0	22
September	5	2	3	1	1	19	0	1	0	32
October	4	6	11	1	4	25	1	0	1	53
November	3	11	15	4	3	20	2	1	1	60
December	2	5	15	4	4	24	0	0	0	54
Average	2	5	6	3	3	14	1	......	......	34

Average number of rigs building in Indiana from 1891 to 1899, by counties.

County.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Adams	1	3	2	4	9	9	6	1	2
Blackford	1	1	1	2	3	9	3	4	5
Grant	......	......	......	1	6	4	1	3	6
Huntington	......	......	......	1	2	3	2	2	3
Jay	2	12	9	8	14	7	4	3	3
Marion	......	......	......	......	......	......	1	2	......
Miami	......	......	......	......	......	......	2	0	1
Wabash	......	......	......	......	......	......	......	1	......
Wells	3	6	9	22	40	18	6	8	14
Miscellaneous	......	......	......	......	......	......	1	1	0
Total	7	22	21	38	74	50	26	25	34

Rigs or derricks building in the Indiana oil fields from 1891 to 1899, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891..	....	....	.....	.....	.....	.....	7	2	12	8	6	6	7
1892..	8	18	23	23	17	21	16	15	29	31	39	19	22
1893..	12	15	17	14	17	26	32	28	9	25	27	30	21
1894..	36	39	34	40	35	30	32	35	35	57	38	32	38
1895..	37	50	73	89	102	91	78	69	83	70	61	80	74
1896..	72	50	53	67	79	48	52	33	32	34	42	24	50
1897..	29	36	34	25	29	22	18	23	37	25	19	12	26
1898..	12	10	12	20	17	25	22	21	41	42	44	26	25
1899..	27	25	24	23	33	29	18	22	32	53	60	54	34

The following table shows the wells completed, the initial production, the dry holes, wells drilling, and rigs building in Indiana in 1899:

Well record in Indiana in 1899.

Month.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	75	1,715	5	59	27
February	48	830	9	57	25
March...............	68	1,365	14	52	24
April...............	64	1,425	5	49	23
May.................	87	2,030	5	62	33
June	99	1,940	7	54	29
July................	77	1,540	12	62	18
August	104	1,875	9	71	22
September...........	106	1,985	12	88	32
October	118	2,010	13	72	53
November............	106	2,141	8	93	60
December	105	2,070	4	100	54
Total	1,057	*a* 1,744	103	*a* 68	*a* 34

a Average.

ILLINOIS.

There has been no apparent change in the output of Illinois petroleum for 1899 as compared with 1898. All the oil is produced from four wells near Litchfield, Montgomery County. The petroleum is dark, having a specific gravity of 22°, and is marketed for lubricating purposes.

Production of petroleum in Illinois from 1889 to 1899.

Year.	Barrels.	Year.	Barrels.
1889	1,460	1895	200
1890	900	1896	250
1891	675	1897	500
1892	521	1898	360
1893	400	1899	360
1894	300	Total	5,926

MISSOURI AND MICHIGAN.

A small quantity of dark, heavy petroleum is produced near Merwin, in Bates County, Missouri, which is used locally for lubricating and as a harness grease. A small yield has also been developed at Port Huron, Michigan. There are six small producers in this section, and the oil is similar to that produced in the Canadian field, nearly opposite.

In the following table is given the production of crude petroleum in Missouri from 1889 to 1899:

Production of petroleum in Missouri from 1889 to 1899.

Year.	Barrels.	Year.	Barrels.
1889	20	1895	10
1890	278	1896	43
1891	25	1897	19
1892	10	1898	10
1893	50	1899	*a* 132
1894	8	Total	605

a Includes the production of Michigan.

KANSAS.

There was a falling off of 3 per cent in the production in this State in 1899, following a decline of 11.24 per cent in 1898.

The production was furnished by the same number of wells in 1899 as furnished the production in 1898. This fact argues favorably for the life of the field, as well as for the careful handling of the wells themselves. About 305 wells have been drilled since 1892. Of this number 83 are producing oil and about 40 are gas wells. Some of the gas wells have an output of nearly 8,000,000 cubic feet a day.

The oil is found in a dark "sugar sand" from 15 to 20 feet in thickness at about 800 feet below the surface. The largest cluster of pro-

ducing wells is located along the river bottom near Neodesha, in Wilson County. The geological position of this sand is near the bottom of what is known as the Cherokee shales. The well records show a series of slate, sand, and limestone from the oil sand to the top. About 300 feet lower, after passing through another series of slate and sand (the lower beds generally holding salt water), the flint beds of the Subcarboniferous limestone are usually found. In this section this formation is known as Mississippian limestone, corresponding to the Subcarboniferous of the Appalachian field. The slate and sands above correspond to the Lower Coal measures of the Eastern States, but contain no coal in this locality, although they do so in other localities in the State. The oil sand is wanting in some wells and in others another sand above holds dark, heavy oil. This section has developed a number of good gas wells, and shows a series of moderate anticlinal and synclinal folds in the floor of the lower rocks.

The petroleum is of a dark-green color of about 40° B. gravity. A small but very complete refinery has been built at Neodesha, from which point the pipe lines reach out 3 to 5 miles to the clusters of wells. There is also a large amount of tankage at this place. An excellent quality of water-white oil is said to be produced from the Kansas petroleum.

The price paid for crude petroleum at the wells during 1899 was 75 cents per barrel, as compared with 50 cents during 1898. The refinery at Neodesha refines all the oil produced and markets its product in the vicinity.

PRODUCTION.

The total production of oil in Kansas, so far as records have been obtained, is as follows:

Production of petroleum in Kansas.

Year.	Barrels.	Year.	Barrels.
1889	500	1895	44,430
1890	1,200	1896	113,571
1891	1,400	1897	81,098
1892	....	1898	71,980
1893	18,000	1899	69,700
1894	40,000	Total	441,879

The following table gives the production, the daily average production, and the average daily production per well for 1897, 1898, and 1899, in Kansas:

Total and average daily production of wells in Kansas in 1897, 1898, and 1899.

Production.	1897.	1898.	1899.
	Barrels.	*Barrels.*	*Barrels.*
Production in year	81,097.71	71,979.65	69,700.34
Daily average production	222.19	197.20	190.96
Average daily well production	3.58	2.63	2.48

The following table gives the monthly production in Kansas in 1898 and 1899:

Production of crude petroleum in Kansas in 1898 and 1899, by months.

Month.	1898.	1899.	Month.	1898.	1899.
	Barrels.	*Barrels.*		*Barrels.*	*Barrels.*
January	7,602	5,843	August	5,537	6,633
February	6,384	5,531	September	4,723	6,112
March	6,562	5,956	October	5,457	5,956
April	6,973	5,374	November	5,224	5,622
May	6,186	5,788	December	5,503	5,603
June	6,570	5,581			
July	5,259	5,701	Total	71,980	69,700

Wells drilled by the Forest Oil Company in Kansas in 1897, 1898, and 1899.

County.	Total wells.			Dry.		
	1897.	1898.	1899.	1897.	1898.	1899.
Neosho	1	1	1	......	1	......
Wilson	5	3	14	1	......	7
Chautauqua	4	......	......	4	......	......
Allen	......	......	2	......	......	......
Total	10	4	17	5	1	7

County.	Gas.			Oil.		
	1897.	1898.	1899.	1897.	1898.	1899.
Neosho	......	......	1	1	......	......
Wilson	2	3	3	2	......	4
Chautauqua	......	......	......	......	......	......
Allen	......	......	2	......	......	......
Total	2	3	6	3	......	4

Total number of oil wells producing in Kansas at close of 1897, 1898, and 1899.

County.	Oil wells producing.		
	Dec. 31, 1897.	Dec. 31, 1898.	Dec. 31, 1899.
Allen		1	
Chautauqua			1
Montgomery	1	1	1
Neosho	16	17	16
Wilson	54	64	65
Total	71	83	83

Average wells producing, 1897 62
Average wells producing, 1898 75
Average wells producing, 1899 77

INDIAN TERRITORY.

A number of wells have been drilled in different parts of the Territory, about 27 in all, nearly all of which were drilled previous to 1896. Very little new work has been done. Operations have been brought to a standstill owing to the difficulty in perfecting a title. The title of the oil and other minerals remains in trust with the United States Government under the direction of the Secretary of the Interior, who must ratify every lease to make it valid. The amount of 640 acres can only be acquired by a single individual or company. Most of the oil produced is heavy and dark, although some of it shows a gravity of 30° to 38° Baumé.

It is not the policy of the Department of the Interior to permit single individuals or corporations to include immense tracts of lands in a large number of separate leases, and at the same time the Department does not seek to deprive any person who has invested money in improvements of the benefits to which he is entitled. The result is to compel parties to do actual developments rather than take up blanket options for speculative purposes.

The Secretary of the Interior has rendered a decision of great importance to those who are engaged in developing the oil field of the Indian Territory. Two corporations have been operating there, one known as the Creek Oil Company and the other as the Cudahy Oil Company, composed principally of Illinois men. The law restricts the number of acres which shall be given to any one person to 640 acres for mineral lands, and the companies claimed the right to acquire any number of these allotments by assignment. The Secretary of the Interior has sent

instructions to the inspector of the Indian Territory that the Department would not recognize the right of individuals who obtained mineral leases to assign them to any corporation.

Owing to the above-mentioned unsettled condition of titles no work has been done during 1898 and 1899. Nearly all of the former production came from the reservation of the Cherokee Nation. The operations were carried on by the Cherokee Oil and Gas Company, who drilled 16 wells, some 5 miles southwest of Chelsea, from 350 to 1,200 feet in depth. Most of them produced a small amount of dark, heavy oil. One well at Eufaula, near the center of the Territory, is reported to have been drilled 2,780 feet deep and was dry. In another well, at Muscogee, a light-green oil of 38° Baumé was found at 1,100 feet.

Production of petroleum in Indian Territory from 1891 to 1899.

Year.	Barrels.	Year.	Barrels.
1891	30	1897	625
1892	80	1898	*None.*
1893	10	1899	*None.*
1894	130	Total	1,082
1895	37		
1896	170		

TEXAS.

This is only the third year that Texas has occupied a place of importance among the petroleum-producing States. Nearly the entire production comes from the Corsicana field in Navarro County. The first well to find this deposit was drilled in 1894 in the city of Corsicana in search of a good supply of water. Petroleum was found at 1,040 feet in a loose sand 20 to 30 feet in thickness, capped by a stiff blue clay. A supply of artesian water is found at a depth of 2,400 feet, 1,350 feet below the horizon of the petroleum. Its geological place in the scale is probably Upper Cretaceous. The oil contains a slight percentage of paraffin, and ranges from 38° to 40° Baumé in gravity. At a temperature of 305° C. 90 per cent is volatilized.

In October, 1895, the first well in search of petroleum was drilled 200 feet south of the original artesian well and a well with a capacity of 2½ barrels secured. In May, 1896, a well was drilled in that made 22 barrels in twenty-four hours. It was this well that gave this section its start in development. Up to the close of 1899 642 wells had been drilled. Of this number 511 produced oil and 13 produced gas, leaving 118 dry holes.

There were 86 abandoned wells up to the close of 1899. Only from twelve to fifteen days are usually required to put a well down to the pay sand. Most of the wells are put down through the clay by rotary machines, and when the production falls to a point that is not profitable the wells are abandoned and the casing "pulled" to be used again in more profitable territory.

The field was somewhat extended during 1899.

A refinery was completed at Corsicana during 1898 with all the known improvements, and the products find a ready market. The refinery has been connected with the wells in the field by an ample system of tanks and pipe lines. The average price of Texas petroleum during 1899 was 70 cents per barrel, as compared with 50 cents in 1898.

The other counties that produce a small amount of lubricating petroleum are Bexar, Nacogdoches, and Hardin. The petroleum in the State, so far developed outside of Corsicana, is dark and heavy, but has good lubricating qualities. There are a number of other localities in this State where dark, heavy petroleum and asphalt are found.

PRODUCTION.

The production of petroleum in Texas since 1889 has been as follows:

Production of petroleum in Texas from 1889 to 1899.

Year.	Barrels.	Year.	Barrels.
1889	48	1896	1,450
1890	54	1897	65,975
1891	54	1898	546,070
1892	45	1899	669,013
1893	50	Total	1,282,869
1894	60		
1895	50		

WELL RECORDS.

The following tables show the number of wells completed, producing, dry, drilling, those producing gas and those abandoned, together with the number of rigs and the production of petroleum in Texas in the years 1898 and 1899.

Well record and production of crude petroleum in the Corsicana oil field in 1898, by months.

Month.	Wells.						Rigs.	Production. *b*
	Completed.	Producing.	Dry. *a*	Drilling.	Gas.	Abandoned.		
								Barrels.
January (*c*)	76	66	10	6	......	......	8	13,797
February	11	9	2	19	......	1	18	20,110
March	25	23	2	17	1	......	13	21,421
April	32	29	3	6	......	......	13	30,276
May	32	31	1	13	......	1	7	31,007
June	26	24	2	8	1	......	20	55,677
July	26	26	......	18	......	......	9	56,649
August	39	38	1	11	1	......	11	58,458
September	29	28	1	14	......	......	18	63,138
October	27	23	4	16	......	3	7	63,227
November	24	23	1	12	1	......	8	63,777
December	27	22	5	14	......	2	4	67,083
Total	374	342	32	*d* 13	4	7	*d* 11	544,620

a Includes two artesian wells. *b* Includes local consumption approximated.
c One-half month estimated and covers all previous operations. *d* Average.

Well record and production of crude petroleum in the Corsicana oil field in 1899, by months.

Month.	Wells.						Rigs.	Production. *b*
	Completed.	Producing.	Dry. *a*	Drilling.	Gas.	Abandoned.		
								Barrels.
January	19	14	5	12	......	2	6	63,975
February	15	13	2	9	......	4	8	50,755
March	21	16	4	9	1	4	5	64,047
April	13	8	5	16	......	2	9	52,938
May	29	11	16	17	2	1	10	57,437
June	29	18	10	14	1	1	9	55,292
July	22	12	10	9	......	3	11	53,836
August	23	9	11	15	3	14	11	53,544
September	23	16	6	15	1	17	10	53,695
October	27	22	5	11	......	11	7	52,961
November	24	16	7	12	1	8	6	52,844
December	23	14	9	15	......	12	3	57,159
Total	268	169	90	*c* 13	9	79	*c* 8	668,483

a Includes two artesian wells. *b* Local consumption estimated. *c* Average.

The following article by Mr. F. C. Thiele and published in the Oil, Paint, and Drug Reporter, is of interest.

An analysis made by the author shows the Corsicana oil to be composed as follows:

Analysis of petroleum from Corsicana, Texas.

	Per cent.	Specific gravity.
Naphtha	10.8	0.710
Kerosene	54.5	.796
Residue	34.7	.905
	100.0	....

Crude oil—specific gravity, 0.8206.

A more elaborate analysis made by Mr. E. H. Ernshaw shows the following composition of the Corsicana oil.

Analysis of petroleum from Corsicana, Texas.

	Temperature.	Percentage by volume.	Percentage by weight.	Specific gravity at 60° F.
Colorless:	*Degrees F.*			
A	130–200	2.80	2.24	0.6653
B	200–250	5.10	4.31	.7017
C	250–300	7.60	6.69	.7302
D	300–350	8.20	7.44	.7527
E	350–400	9.40	8.75	.7718
F	400–450	7.40	7.07	.7920
G	450–500	8.30	8.09	.8088
Very faint yellow:				
H	500–550	6.45	6.43	.8260
I	550–600	7.75	7.85	.8404
Yellow, J	600–650	14.95	15.43	.8555
Deep reddish yellow, K	650–665	17.25	18.07	.8687
Deep red (solid), L, over	650	1.30	1.41	.8972
Dark red-brown (solid), M, over	650	1.40	1.63	.9699
Residue			2.63	....
Total		97.90	98.04	....

Oil very dark brown and opaque, but thin and fluid at 60° F. Specific gravity at 60° F. equals 0.8292.

The above analysis shows the Corsicana oil to be closely related to Pennsylvania oil, especially that of the Washington district, but it contains, according to my researches, a certain amount of asphaltum or bodies very similar to it. The presence of asphaltum compounds in crude oils can easily be demonstrated by the addition of tin tetrachloride, $SnCl_4$, to a sample of the oil in question. If a black precipitate is formed on the addition of the reagent, asphaltum or similar compounds are present

in the oil. I found this reaction to be of value for oils which are subjected to distillation, as oils containing asphaltum should be distilled with great care and a very gradual rise of temperature, so as not to get too large an amount of the terpene-like decomposition products of the asphaltum in the distillates. The presence of these bodies, which resemble aromatic hydrocarbons, tend to color the oil yellow, and even a very effective acid treatment does not seem to improve the oil much in color. This behavior of the distillates resembles the one which oils show when they have been subjected to overheating, as in the case of certain desulphurizing processes, proposed for the purification of strongly sulphur-bearing oils, such as Lima, Canadian, and others.

It was soon found, after the Corsicana oil field was discovered, that oil existed in other places in Texas, and borings for it were rapidly made in a number of places. It soon developed that a well-defined oil stratum existed, which, following the Trinity River to Nacogdoches, and turning here and following the Sabine River, flowed out into the Gulf of Mexico at Sabine Pass, covering the water at times with a black greasy substance over quite a large area.

The oil found at Nacogdoches is very heavy, its specific gravity being 0.915. Its color is black, and it is strongly impregnated with sulphuretted hydrogen. It occurs in shallow wells not over 90 feet deep, and very likely belongs to the class of oils which are described in the literature as maltha.

From Nacogdoches, going south, the oil makes its next appearance at Rockland, the terminus of the Rockland and Sabine Pass Railroad. It is asserted that the oil exists here in large quantities, but no researches regarding its properties have been made. Saratoga, south of Rockland, is the next place where oil deposits are found, and experimental boring has been going on here for some time. The oil found here is still heavier than the Nacogdoches oil, having a specific gravity of 0.995. It is a black oil, rich in asphaltum.

Fourteen miles south of Saratoga is the watering place of Sour Lake, where a large oil deposit occurs. The soil at Sour Lake is undoubtedly of volcanic character, judging by the large variety of waters found here and the general condition of the territory.

The crude petroleum found at Sour Lake occurs at a depth of 250 feet in the alluvial formation, and is what is termed a "surface oil." Its specific gravity at 63.5° F. is 0.963, which is the highest specific gravity observed with any crude oil found on the Western Hemisphere. A fractional distillation of the oil shows the following constituents:

Composition of petroleum from Sour Lake, Texas.

Fraction.	Temperature.	Percentage by volume.	Specific gravity.	Color, etc.
	Degrees F.			
1	----------	----------	----------	
2	212–266	0.07	----------	Yellow.
3	266–320	.03	----------	Yellow.
4	320–392	1.59	0.684	Yellow.
5	392–572	19.49	.840	Yellow; blue fluorescence.
6	----------	----------	----------	
7	572–641	5.15	.782	Dark yellow.
Residue	----------	71.11	.978	Black.
Total	----------	97.44	----------	

The oil contained 20 per cent asphaltum.

The analysis was carried out according to the directions laid down by R. Kissling during his investigations of crude oils of different origin.

The above analysis indicates that the greater part of the oil is composed of hydrocarbons excellently suited for lubricating purposes, and the last fraction has a viscosity of 19° (Engler apparatus), a figure which exceeds that of the heaviest Russian products. Tests which were made on the large scale showed the presence of aromatic hydrocarbons, such as pseudocumene and others, and according to its behavior the crude oil may be called a true representative on American soil of the oil found at Wietze-Steinforde, Germany, which was pronounced by Professor Engler one of the most valuable sources of high-grade lubricating oils, if it could be freed of its asphaltum by proper refining and treatment. Solid paraffin has not been found in the crude oil nor in any of the refined products, and it is doubtful whether any is present.

WYOMING.

This State has some fifteen distinct pools of petroleum scattered over its large area. Most of these have only natural springs to mark their existence, although considerable drilling has been done in various parts of the State. The locations for these wells have often been made without due regard to the known dips of the rocks, and have either reached the oil sand too soon or the depth of the oil sand was beyond the capacity of the machinery. Very few wells were drilled in 1899, and operations were confined to the working of the wells at Salt Creek, close to the north line of Natrona County, where a good natural lubricating petroleum is produced. There is a similar grade of lubricating petroleum near New Castle, Weston County, where three wells have been drilled.

Most of the oil outside of these localities is of a dark color, ranging from 16° to 25° Baumé, produces only a limited amount of illuminating oil, and is not a first-class lubricator in its natural state.

The great inland valleys and plains, with their ridges and mountain chains extending for many miles, with numerous synclinal and anticlinal folds, have, at frequent intervals, been cut through by streams and exposed the rocks down to the Subcarboniferous, the Triassic, and the Jurassic, and the individual members of the great Cretaceous formation. There are numerous places at which the exposed rocks of this Cretaceous formation are still discharging dark, heavy petroleum until miniature lakes are formed. At other points the rocks where they come to the surface are saturated with it. At others natural gas is seen bubbling up in pools of water. All of these facts seem to indicate that Wyoming will one day produce a large amount of petroleum, although many natural difficulties will have to be overcome. The elevation of the State averages about 6,000 feet above tide. The extremes are from 3,000 to 14,000 feet.

The large areas in this State that are cut off from communication and transportation, the long distance to any large center of population, the abundance of good coal, and the scarcity of good water and timber,

together with its comparatively small population, have all been factors that have retarded the development of its petroleum. The day will come, however, when this State will probably furnish a large amount of petroleum. At Salt Creek six wells owned by the Pennsylvania Oil and Gas Company are producing a dark green oil of natural lubricating qualities, of 24° Baumé gravity. The production is between 18 and 20 barrels per day for the whole group. The petroleum is hauled 50 miles south to Casper, on the Fremont, Elk River and Missouri Valley Railroad, by teams, the oil being loaded into tank wagons, a team of 16 to 18 horses hauling 30 to 35 barrels. The first well was drilled in the Salt Creek pool in 1889. The depths of the six wells now producing run from 800 to 1,125 feet. Three strings of casing are required to reach the sand. At Casper this petroleum is distilled and a small amount of light products secured. The main product is a very good quality of lubricating oil, which is thoroughly filtered under pressure to remove a fine sharp sand, and finds a market as car and cylinder oil.

The production has remained steady for the past two years, and so has the price.

Production of petroleum in Wyoming from 1894 to 1899.

Year.	Barrels.	Year.	Barrels.
1894	2,369	1898	5,475
1895	3,455	1899	5,560
1896	2,878	Total	23,387
1897	3,650		

COLORADO.

During the past year the production in this field decreased 54,105 barrels. Thirty dry holes were drilled and four producing wells completed. There were four wells abandoned during the year. The entire production in Colorado is confined to the Florence field, in Fremont County, in the valley of the Arkansas River, only 10 miles east of the eastern base of the Rocky Mountains, and 90 miles west from Denver.

The longer axis of the oil basin extends a distance of 14 miles, holding a course N. 15° W., while the other axis is 8 miles in length. The town of Florence is not far from the central portion of the basin. The Fox Hill group of the Cretaceous formation holds the petroleum in a stratum that is a mixture of clay and sand. The wells are from 1,600 to 2,300 feet in depth, and usually two strings of casing are required.

In some wells three pay streaks are encountered from 200 to 400 feet apart; a well, however, may miss them all. The oil is of a dark green color of about 31° Baumé gravity, and the most of it is refined at Florence.

PRODUCTION.

The following table gives the production, by months, from 1896 to 1899 in Colorado:

Production of crude petroleum in Colorado from 1896 to 1899, by months.

[Barrels of 42 gallons.]

Month.	Production.			
	1896.	1897.	1898.	1899.
January	31,846	26,671	33,327	41,337
February	28,699	24,566	32,433	35,956
March	29,938	26,039	33,670	33,941
April	31,506	23,443	33,132	30,712
May	30,911	27,811	33,163	33,361
June	30,188	33,707	32,749	29,996
July	31,241	40,924	34,643	31,887
August	31,453	41,192	37,221	32,024
September	30,872	38,233	43,051	29,364
October	29,669	35,163	44,749	31,242
November	27,909	32,968	44,575	29,263
December	27,218	34,217	41,670	31,195
Total	361,450	384,934	444,383	390,278

In the following table will be found a statement of the production of crude oil in Colorado from 1887 to 1899:

Production of crude oil in Colorado from 1887 to 1899.

Year.	Barrels.	Year.	Barrels.
1887	76,295	1894	515,746
1888	297,612	1895	438,232
1889	316,476	1896	361,450
1890	368,842	1897	384,934
1891	665,482	1898	444,383
1892	824,000	1899	390,278
1893	594,390	Total	5,678,120

CALIFORNIA.

The activity in prospecting for petroleum in southwestern California noted in the previous year continued throughout 1899. A large number of wells were drilled in extending the old fields and searching for

new ones. There is an immense area in this State which contains rocks and shales, more or less saturated with bitumen, as well as numerous springs, from which petroleum finds its way to the surface.

Along the line of the Coast Range, with its numerous diverging ranges, large areas are found where the strata have been more or less folded, but not changed by heat, that has brought about the conditions favorable for the accumulation of petroleum. The new development of most importance in 1899 was that found in Kern County, 10 miles northeast of Bakersfield. There were other new developments discovered to the south and west of Bakersfield, in the same county. This county added 15,000 barrels to the output of this State in 1899 as compared with 10,000 in 1898, nothing being credited to it for 1897. Fresno County produced 439,372 barrels in 1899, or nearly three times the quantity produced in 1898, when the product was 150,000 barrels.

Nearly all of the petroleum produced in California is dark in color and heavy in gravity. The great bulk of the production comes from Los Angeles, in Los Angeles County.

The heavy petroleum ranges from 12° to 18° Baumé. That produced in Fresno County is light in color, and most of it is as light as 34° Baumé in purity.

The principal market for petroleum in this State is for fuel purposes, owing to the scarcity and high cost of coal and other fuel on the Pacific coast. Some of the lighter products of the heavy oils are taken out by refining. The light oil from Fresno County is chiefly used in the manufacture of gas. California oil is used extensively as fuel in sugar manufactories, in generating steam for electric-light and power plants, in pumping water, in refineries and pumping wells. It is also being introduced extensively as locomotive fuel, and to some extent in the manufacture of iron and steel. Another rather novel use to which California petroleum has been put is the improvement of public roads; 100 barrels per mile is sprinkled on a roadway 18 feet in width. Sixty barrels are employed at first, and two subsequent applications of 20 barrels each. The best results are secured on a dry, dusty road, where it combines with the dust and forms a hard surface, which is durable and free from dust. The oil is applied while hot. In the region of Los Angeles repeated trials have proved it to be a great success. A portion of the petroleum is refined at Oleum, near San Francisco, and at Santa Paula, Newhall, and Los Angeles. Some very satisfactory grades of lubricating oil are also produced. The illuminating oil, however, will not compare favorably with Eastern illuminating oil.

Crude petroleum is transported along the Pacific coast as far north as San Francisco and Oleum in steel barges. The crude oil is collected in storage tanks at Wilmington, in southern Los Angeles County, Ventura, and Santa Barbara.

PRODUCTION.

The production of crude petroleum in California in 1899 was 2,642,095 barrels, valued at $2,508,751, about 95 cents a barrel. As compared with 1898, there was an increase of 384,888 barrels in production and 10 cents in average price per barrel. Los Angeles County, which takes first rank in amount of production, produced 1,398,442 barrels, valued at $1,332,690, or 95.3 cents a barrel. Of the total quantity produced in Los Angeles County, 1,032,966 barrels, valued at $960,726, or 93 cents a barrel, were produced in Los Angeles city. The other counties of California which produced petroleum, as reported to this office and ranged according to their output, were Ventura, Fresno, Santa Barbara, Orange, and Kern, the combined product being 1,243,653 barrels, over one-third of which was produced in Ventura County, about one-third in Fresno County, nearly one-sixth in Santa Barbara County, and the balance in Orange and Kern counties.

The following table gives the yearly production of petroleum in California from 1876 to 1899, that previous to 1876 being estimated:

Production of petroleum in California.

Year.	Barrels.	Year.	Barrels.
Previous to 1876	175,000	1889	303,220
1876	12,000	1890	307,360
1877	13,000	1891	323,600
1878	15,227	1892	385,049
1879	19,858	1893	470,179
1880	40,552	1894	705,969
1881	99,862	1895	1,208,482
1882	128,636	1896	1,252,777
1883	142,857	1897	1,903,411
1884	262,000	1898	2,257,207
1885	325,000	1899	2,642,095
1886	377,145	Total	14,739,391
1887	678,572		
1888	690,333		

The State Mining Bureau furnishes the following figures on petroleum production for 1897, 1898, and 1899, by counties:

Production of crude petroleum in California as reported by State Mining Bureau.

[Barrels of 42 gallons.]

County.	1897.	1898.	1899.
Fresno	70,140	154,000	439,372
Kern		10,000	15,000
Los Angeles	1,327,011	1,462,871	1,409,356
Orange	12,000	60,000	108,077
Santa Barbara	130,136	132,217	208,370
Santa Clara	4,000	3,000	1,500
Ventura	368,282	427,000	496,200
Total production	1,911,569	2,249,088	2,677,875
Total value	$1,918,269	$2,376,420	$2,660,793

The above figures are slightly in excess in production and value of that reported on previous page.

REPORT OF THE CALIFORNIA STATE MINING BUREAU.

The following paper consists of extracts from the report of Mr. W. L. Watts, which will shortly be issued as a bulletin by the California State Mining Bureau:

The object of this paper is to summarize the leading facts concerning the occurrence of petroleum in California. This mineral, in the form of natural gas, oil, and asphaltum, is found at various places in the Coast Range. The greatest showing of petroleum and the greatest development of the petroleum industry are south of San Francisco. Oil and gas are found in Kern County, in the foothills of the Sierras, and natural gas is found in the great central valley of California. It is said that this gas has also been observed in other counties, including the foothills of the Sierras.

The geological formations yielding petroleum in California range from the Lower Cretaceous to the Quaternary; and in different localities the geological horizon of the productive strata differs in point of vertical range. In the Puente Hills and at Los Angeles the oil-yielding rocks are of Neocene age. These formations were first classed as Pliocene, on account of the numerous Pliocene fossils found in them.

On the south side of the valley of the Santa Clara River, in Ventura and Los Angeles counties, the principal oil-yielding formations probably range from the Neocene to the Miocene. The writer has not yet made a detailed examination of these oil fields.

On the north side of the valley of the Santa Clara River, in Ventura County, there is evidence of petroleum in rocks ranging from the Upper Neocene to the Lower Eocene formations, the productive formations ranging from the Miocene to the uppermost portion of the Eocene.

In the foothills west of Bakersfield, in Kern County, petroleum is found in formations ranging from the Eocene to the Neocene, and heretofore classed as Pliocene, but the oil-yielding formations which have been tested by drilling are supposed to be of Miocene age.

Natural gas and some oil have also been obtained in the foothills of the Sierras east of Bakersfield, the formation being either of Pliocene or of Neocene age.

In Fresno County and Kings County there are exudations of petroleum from rocks of Miocene age, but the petroleum-yielding formations near Coalinga, in Fresno County, which have recently proved very remunerative, appear to be of Eocene age, formerly called Cretaceous B.

The geological horizon of the oil-yielding rocks at Moody Gulch, Santa Clara County, has never been determined.

Some oil has also been obtained on the Tunitas and the Purissima creeks, in San Mateo County, from wells which penetrate strata which are probably of Eocene age.

North of San Francisco petroleum-yielding formations crop out along the coast at Bolinas Bay and at Point Arena. At these places the exposed rocks are either of Pliocene or of Neocene age.

In Humboldt County several wells from which some oil has been obtained have been drilled, the rocks penetrated being either of Pliocene or of Neocene age.

On Bear Creek, in Colusa County, gas and oil are found in rocks of Cretaceous age.

It is reported that in some places petroleum is found permeating eruptive or other crystalline rocks.

At Stockton, in San Joaquin County, natural gas is obtained in remunerative quantities from wells permeating strata of Quaternary age.

At Marysville Buttes, in the Sacramento Valley, natural gas is found in rocks of Eocene age, formerly called Cretaceous B. There are several places in Sacramento and San Joaquin valleys where wells are yielding sufficient natural gas to be of local value.

The relative position in point of vertical range of the formations wherein remunerative oil wells have been obtained in Ventura and Los Angeles counties is demonstrated by an investigation of the country between the Piru and Sespi creeks, in Ventura County, where the following sequence of formations can be seen: At the Piru Creek a conglomerate formation is seen containing Neocene fossils, Pliocene forms being the most numerous. In some places the conglomerate is impregnated with petroleum; it rests on a shale formation containing Neocene fossils. The lower portion of the shale is interstratified with sandstone, which in many places is forming an oil sand, the outcropping strata of which resemble the oil sands seen in the Puente Hills, in Los Angeles County. The shale rests on a whitish sandstone of Miocene age. This whitish sandstone contains remunerative oil-yielding strata.

The conglomerate, the shale, and the whitish sandstone in Ventura County constitute a group corresponding to a group of certain conglomerates, shales, and sandstones which the writer carefully studied in the Puente Hills, in Los Angeles County. These formations probably form a large portion of the rocks in the oil districts of Los Angeles and Ventura counties, and in both of these counties these formations are of similar character and contain fossils of similar age.

As observed in the Puente Hills, in Los Angeles County, these whitish sandstones, shales, and conglomerates rest on one another in the order here named. The principal oil-yielding formations found in these hills and in the city of Los Angeles are certain oil sands which interstratify the lower portion of the shale formation and probably constitute the uppermost strata of the underlying sandstones.

The whitish sandstone formation extends westward from the Piru Creek, in Ventura County, to the Sespi oil district, also in Ventura County, the distance between the two places being about 8 miles.

At the Sespi oil district the whitish sandstone rests on a shale formation, whitish and grayish at the top, but passing into a dark-colored shale, which is interbedded with numerous thin strata or nodular masses of hard bituminous limestone. These shales contain Miocene and Eocene fossils, and rest on a drab-colored sandstone of no great thickness. The drab-colored sandstone rests on a brown sandstone, locally

known as the Sespi brownstone. This brownstone rests on white sandstone and the latter on a buff-colored sandstone. The Sespi brownstone, the white sandstone, and the buff-colored sandstone all contain typical Eocene fossils. All these sandstones are more or less interbedded with shale. The principal oil-yielding formations in the Sespi district are the lowermost portion of the dark-colored shales, the drab sandstone, and the uppermost portion of the Sespi brownstone.

There are numerous seepages of petroleum in the hard, buff-colored Eocene sandstones, but no remunerative oil wells have as yet been obtained by drilling in these rocks.

Between the Piru Creek and the Sespi district no marked nonconformity was observed by the writer, the variations of dip being referable rather to local geological disturbance than to nonconformability. Still, it by no means follows that the formations actually rest conformably on one another. It is generally believed that in California the Miocene formations rest nonconformably on the Eocene. Observations in Los Angeles and Orange counties lead to the conclusion that the Neocene shales overlap the whitish sandstones, and there are some reasons for believing that the conglomerate rests nonconformably on the Neocene shales.

Since the Eocene period there have been not only epochs of unusual geologic disturbance, but also disturbance of a chronic nature, which has been contemporaneous with the deposition of the Tertiary and Quaternary formations. Similar disturbances continue to this day. It appears that in many instances these disturbances were of a local character.

The formations penetrated by remunerative oil wells in such portions of Los Angeles, Orange, and Ventura counties as have been examined by the writer are as follows:

In the territory extending between the Santa Ana River in Orange County and the ocean at Santa Monica, in Los Angeles County, remunerative oil sands have been found in the lower portion of the Neocene shales, and probably in the upper portion of the Miocene sandstone. In one instance oil was found in the overlying conglomerate.

At the Modello oil wells, near Piru, in Ventura County, remunerative oil sands have been found in the whitish sandstones of Miocene age.

In the Sespi district remunerative oil sands have been found in the upper portion of the Eocene sandstones and in shales which appear to occupy a position between the Miocene and Eocene formations.

It is probable that these oil-yielding localities have their counterpart in many other places in California besides those which have been mentioned, for the geological formations constituting these oil measures extend along the Coast Range from San Diego County to Humboldt County. We have not yet obtained sufficient geological evidence to warrant the expression of anything more than a tentative opinion concerning the actual geological horizon of the petroleum formations in the following oil fields: The oil fields on the south side of the Santa Clara River, those north of Santa Paula, in Ventura County, and those of Santa Barbara, Kern, Santa Clara, and San Mateo counties, but the data already accumulated warrants the assertion that the oil measures in the localities referred to are of Tertiary age.

From the description of the oil-yielding formations the geological position of which has been definitely determined it appears that the productive strata are sandstones underlying or interstratifying bodies of shale. It may be argued that these conditions indicate natural distillation as the chief cause of the accumulation of petroleum in the oil measures.

In many parts of California we find petroleum-yielding formations associated with shales which show signs of having been subjected to metamorphic action. It is reasonable to infer that the petroleum, having been elaborated in the shale, may have been driven out of it by natural distillation into inclosing or interstratifying beds of sandstone.

It must also be borne in mind that in other instances petroleum may have been collected, by upward distillation, from sedimentary strata underlying the shale.

A very small percentage of petroleum, originally distributed through a great thickness of strata, might be driven into different zones by natural distillation, and at certain temperature and pressure it would pass readily through sandstone. The upward course of the petroleum might be impeded by strata of shale, and when the temperature decreased the petroleum might condense in any rocks sufficiently porous to afford it storage. If the shale were only partially impervious to the petroleum the former would be more or less permeated by the latter, and fractures in the shale would give the petroleum access to overlying formations.

A modification of such processes by gas or hydrostatic pressure would be quite sufficient to bring about a redistribution of the petroleum and the formation of secondary deposits of that mineral.

The oil-yielding formations of California, in common with the other rocks of the Coast Range, show great geological disturbance, and the complex structure resulting therefrom has given rise to somewhat difficult geological problems in regard to the oil fields of this State.

In a general way it may be said that the oil lines, or lines along which remunerative wells may be found, follow the strike of the axes of folds in the rocks or the course of faults which have isolated blocks of strata inclosing the oil-yielding rocks. The tracing of oil lines in this State and the development of oil fields necessitate a competent knowledge of structural geology, without which the risks of oil mining would be greatly increased. The type of folds most likely to be met with in the oil fields of California and the effect of such folds on oil lines have been discussed in a paper by the writer in the Mining and Scientific Press of August 5, 1898.

The depth of oil wells depends on the angle at which the oil sand dips and the distance the wells are from the outcrop of the oil sand, or from the axis of the fold on which the wells are situated.

As a general statement, it may be said that the most productive wells are about 1,000 feet in depth, some being much deeper.

The "life" and yield of such wells are naturally varied. In some instances they "started off" with a yield of 100 barrels or more a day; but in the course of five or six years the yield diminished to 10 barrels or less a day. In other instances the first yield was less than 100 barrels a day, but the rate of production was better sustained during the "life" of the well.

In some oil fields the wells are considerably less than 1,000 feet in depth, but, as a rule, their yield is not so great as that of the deeper wells.

The most remarkable features in the recent history of the petroleum industry in California have been the development of the Los Angeles oil field, of the Summerland oil field, in Santa Barbara County, and of the oil field near Coalinga, in Fresno County. In the Los Angeles oil field, which is in the residence portion of the city, between 1,000 and 1,100 wells have been drilled within an area of about 2¼ miles in length and less than a quarter of a mile in width. The depth of these wells ranges from 600 feet to more than 1,200 feet.

Naturally, the "life" of the wells, drilled so close together in the Los Angeles oil field, has not been of great duration. Their yield during the first six months of their "life" averaged about 12 barrels of oil a day. In the Los Angeles oil field there are two strata of oil sand; and the "life" of the wells, which penetrate only the first stratum of sand, has been about three years. The wells which penetrate both the first and the second strata of oil sand, however, are of longer life; some have been producing oil for more than four years.

In June, 1898, 647 wells were being pumped in the Los Angeles oil field, which produced about 2,200 barrels a day. The gravity of the oil ranges from 12° to 17° Baumé.

The Summerland oil field is situated about 4 miles east of Santa Barbara. The first oil well in this locality was drilled in 1890, by Mr. H. L. Williams. Subsequently, wells were sunk, remarkable for the amount of gas they yielded at a shallow depth. (See Seventh, Tenth, and Thirteenth Reports of the California State Mining Bureau.)

In 1895, there were 28 productive oil wells at Summerland, as stated in Bulletin 11, issued by the mining bureau in 1896.

The following quotations from Bulletin 11 describes the situation in Summerland, so far as it was indicated by the exposed rocks and the wells drilled at that date:

"These wells are situated a short distance from the ocean, along a line running N. 85 W. This direction corresponds to the strike of the oil-yielding formations. If this line were extended westward, it would pass a little south of the 455-foot well, drilled in 1890 by Mr. Williams, at the summit of Ortega hill. There is a reasonable probability, therefore, of obtaining productive wells between this line and the ocean; and the wells drilled by Mr. Fischer, at Loon Point, show that the oil-yielding formations extend eastward from Summerland for more than a mile. It is also evident that the oil-yielding formations extend south into the ocean; for not only are oil-yielding strata penetrated by the Fischer wells, but at low tide springs of gas and oil are uncovered on the seashore."

The Coalinga oil field, in Fresno County, has been under process of development during the last two years; and, by all accounts, it bids fair to rival, and some say to excel, the Los Angeles oil field in the quantity as well as the quality of its product. It is said that 60,000 barrels of oil were shipped from the Coalinga oil field during the month of June, 1899. In 1894 the writer made a reconnaissance of portions of the foothills on the south side of the San Joaquin Valley, and, as described in Bulletin 4 of the California State Mining Bureau, prospects of petroleum were found in many places.

A sample of Coalinga oil, obtained by the writer in 1893 from an old well, showed a gravity of about 34° Baumé. A sample from another well, in the same oil field, was examined by Dr. Salathe in 1896.

It is not within the scope of this paper to discuss the vexed question as to the origin of petroleum, which has been treated exhaustively by many competent writers.

An able résumé of the subject may be found in a paper by Mr. A. S. Cooper, State mineralogist, in the Mining and Scientific Press, for February 4, 1899.

He certainly makes out a very strong case for the theory of the vegetable origin of petroleum. This, of course, refers principally to marine vegetation. There is no doubt that the ancient seas contained accumulations of fucoids similar to that in the Sargasso Sea, which, at the present day, is hundreds of thousands of square miles in extent, "and in places is dense enough to impede the progress of vessels."

With the exception of a sample of oil from the Cretaceous formations of Colusa County, all the samples of oil which have been examined by the writer showed an asphaltic base, i. e., the residuum, after the distillation of the lighter hydrocarbons, was an asphalt, or a heavy tar of asphaltic character. These asphaltic oils form asphaltum on exposure to the atmosphere.

The residuum from the distillation of the Colusa County oil is not an asphalt; physically, it resembles the residuum from eastern asphaltum. The Colusa County oil does not form asphaltum on exposure to the air.

Two samples of the Colusa County petroleum were distilled by the writer, and their distillates compare with distillates from a sample of asphaltic oil, as follows:

Results of distilling California petroleum.

Sample A from Colusa County.	By volume.	Specific gravity.
	Per cent.	
Crude oil	....	0.982, about 12° B.
Distillate below 250° C	1	
Distillate between 250 and 325° C	60	.950, about 17° B.

Nearly all the distillates came over at 300° C.

Sample B from Colusa County.	By volume.	Specific gravity.
	Per cent.	
Crude oil	....	0.9835, about 11° B.
Distillate below 280° C	Traces.	
Distillate below 300° C	16.250	.9111, about 24° B.
Distillate below 350° C	3.122	.9600, about 16° B.
At a somewhat higher temperature	43.750	.9788, about 13° B.

This sample contained B. S. (sludge).

Sample of oil from Los Angeles.	By volume.	Specific gravity.
	Per cent.	
Crude oil	....	0.9534, about 17° B.
Distillate below 150° C	Traces.	
Distillate below 200° C	Traces.	
Distillate below 250° C	8	.8330, about 38° B.
Distillate below 300° C	13.6	.8653, about 32° B.
Distillate below 350° C	3	

The ultimate analyses of samples of oil from California and the Eastern States compare as follows:

Ultimate analyses of Pennsylvania, West Virginia, and California petroleums.

Locality where oil was obtained.	Specific gravity.	Nearest degree.	C.	H.	O.	N.	S.	By whom analyzed
Oil Creek, Pa.	0.730	62° B.	82	14.8	3.2	.....	.....	Deville.
West Virginia.	.840	36° B.	84.3	14.1	1.6	.....	.....	Do.
California	.....	.....	86.934	11.817	.....	1.1095	.....	Peckham.
Do	.920	22° B.	84	12.7	1.2	1.7	0.4	Salathe.

An examination of the foregoing table shows that the California oils contain more carbon than do the oils from the Eastern States. Concerning crude oils from Los Angeles and Ventura counties, Dr. Salathe says:

"These crude oils, which all carry asphalt, held in combination with the high-boiling members of the hydrocarbon series, are of a very complex constitution, which

makes their refining exceedingly difficult. By a series of chemical reactions and fractional distillations, I have succeeded in isolating various hydrocarbons, which define clearly the presence of the following hydrocarbon series:

"(a) Hydrocarbons of the paraffin or fatty series.

"(b) Hydrides, or hydron, additional products of the benzole series and homologous hydrocarbons.

"(c) Pyridin and chinolin series.

"(d) Isomeres of the terpene series.

"(e) Sulphurette hydrocarbons.

"(See Résumé of Original Researches and Analysis and Refining Methods of Petroleum, mainly from the southern counties of California, by F. Salathe, Ph. D., in Bulletin 11 of the California State Mining Bureau.)"

Several years ago a careful examination was made, by Dr. C. P. Williams, of certain of the lighter distillates from southern California petroleum. His experiments showed that the samples tested were composed of the following hydrocarbons:

Composition of petroleum from southern California.

Hydrocarbon.	Aproximate amount contained in sample.
	Per cent.
Paraffin	25
Olefine	30
Aromatic hydrocarbons	20
Naphthalene	25

As is well known, the petroleum of the Eastern States is composed principally of hydrocarbons of the paraffin series.

As previously mentioned, by far the greater portion of the California oil is used as fuel, and that in a crude state. A portion is used for fluxing asphaltum and for the manufacture of illuminating gas, and a portion is refined. The portion refined yields crude naphtha, illuminating oil, gas distillate, lubricating oil, and asphaltum.

The naphtha distilled from the California oils is of special value for use in gasoline engines. Those who have made comparative tests of California and Eastern gasoline, in gasoline engines, claim a superiority for the California product.

As might be expected from the foregoing statements, concerning the relative composition of petroleum from the Eastern States and the asphaltic oil of California, illuminating oil manufactured in this State contains more carbon and less hydrogen than does illuminating oil manufactured from Eastern petroleums. The result is, that when burned under similar conditions, California illuminating oil gives a more smoky flame than does oil manufactured from Eastern petroleum. This is due to the fact that it requires more oxygen to effect the complete combustion of carbon than it does to consume hydrogen.

As previously stated, the petroleum obtained from the Cretaceous formations of Coluso County, in California, is not an asphaltic oil. Should the petroleum from this county prove to be a paraffin and be obtained in sufficient quantities, it might yield distillates which would blend with the illuminating oil manufactured from our asphaltic petroleum, and offset the excess of carbon which it contains.

A comparison of the fractional distillations of the Coluso County oil with that of the asphaltic oil from Los Angeles shows a marked discrepancy in the boiling point and the specific gravity of the distillates; the excessive gravity and high boiling point of the Colusa County oil indicate that it is a valuable lubricant.

There is no doubt that, as time goes on, more use will be made of the constituents of our asphaltic oils in chemical manufacture. One use was pointed out by Dr. Salathe, who says: "The occurrence of pyridin and chinolin bases in California crude oils opens up a new resource for these products, which are largely used for the synthetical production of alkaloids, dyes, etc., and in a large measure for denaturalizing alcohol in Europe."

As previously mentioned, the greater part of California oil is used as fuel. It is the general opinion of those who use oil as fuel that weight for weight there is not much difference between the fuel value of oils of different specific gravities, provided the oils are clean, or a suitable allowance is made for water and other foreign substances which they may contain.

In 1896 the writer made calorimetric experiments on the fuel value of California petroleum, as stated in Bulletin 11, part 4, Chapter III, of the California State Mining Bureau. In the publication referred to the fuel value of the petroleum, as determined by the calorimetric experiments, is compared with the fuel value of Nanaimo coal; also with the fuel value of petroleum as computed from practical working tests in locomotives on the Southern California Railroad. In Bulletin 11 there is also a record of calorimetric tests of the fuel value of petroleum made by Prof. H. Stillman in the laboratory of the Southern Pacific Railroad. In 1898 calorimetric tests were made on samples by Messrs. Jaffa and Colby, of the University of California. The samples tested were of a heavy grade of petroleum from Summerland, Santa Barbara County. The fuel values, determined by these different estimates, compared as follows:

Fuel values of petroleum compared.

Kind of fuel.	Available heat units in 1 kilogram).	Available heat (units in 1 ton, calculated as 909 kilograms).	One ton of 2,000 pounds of Nanaimo coal and equivalent in barrels of petroleum.
Nanaimo coal	6,684	6,075,756	....
Sample of petroleum, 15° B., from practical working test in locomotives on Southern California Railroad	....	9,886,585	3.87
Sample of crude petroleum, 16.5° B., tested by Professor Stillman	9,800	8,908,200	3.49
Sample of lubricating oil, 16° B. to 17° B., tested by Professor Stillman	10,788	9,796,192	....
Sample of Los Angeles oil, 13° B., tested by W. L. Watts	10,203	9,274,527	3.63
Maximum fuel value obtained in calorimetric tests by W. L. Watts	10,381	9,436,329	3.69
Minimum fuel value obtained in calorimetric tests by W. L. Watts	9,991	9,081,819	3.55
Sample of Summerland oil (crude) tested by Messrs. Jaffa & Colby.	9,688	8,806,392	3.45
Sample of Summerland oil extracted by naphtha by Messrs. Jaffa and Colby	10,242	9,309,978	3.64

It will be observed that the practical tests in locomotives on the railroad gave a higher fuel value to the petroleum than did the calorimetric tests in the laboratory. This is due to the fact that in a furnace a more complete combustion of petroleum can be secured than it is possible to obtain of coal.

In the calorimetric tests made by the writer the petroleum was cut with gasoline and the fuel value of the gasoline was deducted from the total calorific value. By this method an estimate was obtained which corresponds to that by "the gasoline cut," in common use among oil dealers for determining the amount of foreign matter in petroleum.

"The gasoline cut" consists in mixing in a graduated glass equal volumes of crude oil and gasoline. The water and foreign matter sink to the bottom of the oil, and the relative amounts of oil and foreign matter may be noted by reading the scale on the side of the graduated glass at the point of contact between the oil and the residuum. The residuum at the bottom of the glass consists of earthy matter, water, and sludge, or B. S., as it is known to the trade. In many instances the sludge, or B. S., constitutes several per cent of the sample. It is usually a brown, flocculent precipitate, heavier than oil and lighter than water; it is said to be an emulsion of petroleum and water. The calorific value of the sludge was estimated by Messrs. Jaffa and Colby at 4,149 kilogram calorics, or a little more than 40 per cent of the fuel value of the sample of oil, which was dissolved in naphtha.

The relative fuel value of coal and Los Angeles oil, as shown by combustion in furnaces, is as follows:

The heating furnaces of Los Angeles Steel and Iron Company, 1 ton Wellington coal equals 2.50 barrels of oil; for steam purposes, 1 ton Wellington coal equals 3 barrels of oil.

Los Angeles Consolidated Electric Railroad Company, steam purposes, 1 ton Wellington coal equals 3.62 barrels of oil.

Los Angeles court-house, steam purposes, 1 ton good coal equals 3.10 barrels of oil.

Southern California Railroad Company, steam purposes, 1 ton Nanaimo coal equals 4 barrels of oil.

UTAH.

For several years ozocerite or natural paraffin was mined in this State, but of late the accessible deposits have been exhausted. In eastern central Utah there are numerous hydrocarbons present in highly charged slates and shales. There are quite a number of these solid hydrocarbons found scattered over an area of 10,000 square miles in Carbon and Wasatch and Utah counties, Utah, and a part of Routt and Garfield counties, in Colorado. The several varieties are known as black wax or ozocerite, elaterite, sandstone asphaltum, limestone asphaltum, albertite, oil shales, and several varieties of gilsonite. This latter is mined extensively and manufactured into varnishes and waterproof mineral paints.

ARIZONA.

Petroleum is reported to have been found in northwestern Arizona, in Mohave County. A strip of country, 3 or 4 miles wide, commencing near the summit of the Chemelmeyis Range and extending to the Colorado River, a distance of about 10 miles, has numerous showings of a dark sand saturated with petroleum, which can be squeezed out by a little pressure in the hand.

MONTANA.

A dark, heavy petroleum resembling asphalt is found in Park County, Montana.

ALASKA.

Nothing so far has been done toward the development of the surface indications near Cape Yakutat, Cape Martin, and Kachewak Bay, and the conditions remain the same as reported in 1898. An expedition with men, tools, and machinery destined for the last-named point was shipwrecked and the tools and machinery lost.

FOREIGN COUNTRIES OF THE WESTERN CONTINENT IN WHICH PETROLEUM IS FOUND.

CANADA.

During 1899 little in the way of new developments occurred in the Canadian oil fields, with the exception of some new production found at Dutton and a number of new wells that have been drilled between Petrolia and Sarnia.

The main work of the year was the operation of wells already drilled. Almost all the petroleum produced in Canada comes from southeastern Ontario, its source being the shallow Corniferous limestone, at a depth ranging from 375 to 420 feet. Very little petroleum has been produced from any other strata in Canada. Several deep wells were drilled into the Trenton limestone, none of which found anything but salt water in that formation. The top of the Trenton lies about 3,200 feet below the surface in the trough of the great salt basin at Petrolia, between Lakes Erie and Huron. This great basin begins in New York and ends in Michigan. In this basin the measures known as the Onondaga or salt group and associated formations have thickened up about 500 feet from the Corniferous limestone to the top of the Medina red formation. In some instances as much as 250 feet of solid rock salt, in a distance of 350 feet, has been cut by the drill. Several wells have reported two solid beds, each 100 feet thick, separated by only a few feet of shale.

The production of Canadian oil, as seen in the following table, was 704,794 barrels in 1899, as compared with 750,000 barrels reported in 1898. Obtaining the statistics of the output of crude oil from the different fields is attended with considerable difficulty, as many deliveries are made directly to the numerous railroads in this section.

As all of the oil manufactured in Canada must undergo an inspection by an agent of the Government, the figures relating to the production of refined oil must be quite accurate. It has been proved by several years of comparison that the manufactured products represent 42 per cent of the total production of crude oil.

The finished products inspected during 1899 amounted to 11,927,981 gallons, and as this only represents 42 per cent of the total the number of gallons of crude petroleum would be 28,399,955, which is equal to 808,570 barrels. This amount has only been exceeded once—in 1894—when it was but a little greater. The value of petroleum increased 8⅗ cents a barrel during 1899 as compared with 1898, and the total value was $1,202,020, the largest for any year up to this date. The value of the finished products of petroleum in Ontario has been placed by the Government at $2,806,837, which shows petroleum to be the most valuable of all the mineral products of the district and represents more than 25 per cent of the mineral output of Ontario.

Petrolia was formerly the center of the refining interests. In 1898 a modern refinery was completed by the Imperial Oil Company at Sarnia, on the St. Clair River, near the southern extremity of Lake Huron. This point has an abundant supply of water, which was lacking at Petrolia, better railroad connections, and the great advantage of distribution that the lakes afford.

This refinery is connected with Petrolia and Oil Springs by pipe line. Most of the petroleum from the outlying small pools is shipped by railroad. The price of crude petroleum was $1.40 per barrel for the first three months of 1899, while at the close of the year it brought $1.66½; the average for the year was $1.48⅗ as compared with $1.40 for 1898. This petroleum is much the same as the Lima-Indiana petroleum of the United States and requires a similar special treatment to remove the sulphureted hydrogen from the products of the crude. The average price of Lima-Indiana crude petroleum was 87½ cents per barrel for 1899. The higher value of the Canadian petroleum is owing to an import duty on the crude petroleum of $1.12 per barrel, $2.52 on illuminating, and $2.10 on lubricating oil.

The imperial gallon of Canada contains 277.27 cubic inches as compared with 231 cubic inches for the United States gallon, and has one-fifth greater capacity. The Canadian barrel of 35 gallons, which is their standard, contains 2.4 cubic inches more than the United States barrel of 42 gallons of 231 cubic inches, so that the one standard may be regarded as almost the exact equivalent of the other.

During the year ending June 30, 1900, there were imported into the Dominion of Canada 10,220,268 gallons of all grades of manufactured oil, a very small amount of crude petroleum being included. Deducting one-fifth, to reduce this amount to the equivalent of the Canadian gallon, makes the total 8,176,214 gallons, as compared with 11,005,804 gallons manufactured from Canadian petroleum. Of the total consumption of oil manufactured from petroleum in 1899 in the Dominion of Canada, the Province of Ontario produced nearly 60 per cent, while the remaining 40 per cent was furnished by the United States, which paid the duty.

PRODUCTION.

The Imperial Oil Company, Limited, of Canada, has made the following statement of the production of crude petroleum in Canada in the years 1898 and 1899, by districts:

Production of crude petroleum in Canada in 1898 and 1899, by districts.

[Barrels of 35 imperial gallons, or about 42 standard gallons.]

District.	1898.	1899.
Petrolia	513, 179	*a* 528, 641
Oil Springs	133, 366	*b* 107, 487
Bothwell	66, 404	65, 044
Plympton	25, 000	....
Dawn	5, 923	....
Euphemia	5, 227	....
Zone	901	....
Dutton	....	3, 622
Total	750, 000	704, 794

a Includes production from Plympton.
b Includes the production from Dawn, Euphemia, and Zone.

SHIPMENTS.

Shipments of crude petroleum and refined petroleum reduced to crude equivalent, by railroad, from Petrolia, Canada, in 1898 and 1899.

[Barrels of 35 imperial gallons, or about 42 standard gallons.]

Month.	1898.			1899.		
	Crude.	Refined.	Crude equivalent.	Crude.	Refined.	Crude equivalent.
January	15, 778	17, 285	58, 991	11, 673	8, 350	32, 448
February	12, 044	15, 067	49, 712	17, 009	5, 133	29, 842
March	11, 882	13, 240	44, 982	10, 698	3, 646	19, 813
April	9, 934	9, 832	34, 514	5, 939	1, 361	9, 342
May	14, 480	7, 214	32, 515	14, 131	4, 350	25, 006
June	15, 507	8, 464	37, 667	6, 336	8, 427	27, 404
July	12, 505	8, 213	33, 038	3, 324	5, 084	16, 034
August	11, 856	15, 142	49, 711	2, 648	4, 310	13, 423
September	11, 286	21, 239	64, 384	2, 894	6, 336	18, 734
October	9, 508	24, 493	70, 741	4, 013	12, 660	16, 726
November	12, 757	19, 783	62, 215	8, 613	3, 815	18, 151
December	12, 899	20, 061	63, 052	2, 470	2, 117	7, 763
Total	150, 436	180, 033	601, 522	89, 748	65, 589	234, 686

The following table gives the shipments of petroleum, and refined petroleum reduced to crude equivalents from the Petrolia oil field, by railroad, in barrels, for each month, from 1894 to 1899:

Shipments of crude petroleum from the Petrolia (Ontario) oil field from 1894 to 1899.

[Barrels of 35 imperial gallons, or about 42 standard gallons.]

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	101,570	89,462	83,495	82,556	58,991	32,448
February	76,183	83,497	66,797	67,178	49,712	29,842
March	60,661	66,943	65,283	52,971	44,982	19,813
April	73,463	60,287	71,133	35,572	34,514	9,342
May	67,369	64,120	43,386	60,572	32,515	25,006
June	57,830	59,982	48,459	54,991	37,667	27,404
July	69,586	62,410	60,833	47,622	33,038	16,034
August	86,345	78,173	78,518	71,953	49,711	13,423
September	109,973	102,309	116,144	103,351	64,384	18,734
October	156,163	141,787	129,913	121,238	70,741	16,726
November	122,513	101,100	103,834	106,625	62,215	18,151
December	97,170	102,115	94,486	82,257	63,052	7,763
Total	*a* 1,078,826	1,012,185	962,281	886,886	601,522	*b* 234,686

a About 10,000 barrels were shipped by pipe line.

b A quantity shipped by pipe line, amount of which could not be ascertained.

The large falling off in the shipments by railroad from Petrolia is mainly due to the opening up of the pipe line and the diversion of the trade to Sarnia, where an extensive refinery has been erected.

The figures for 1899 were published in the press of Petrolia and are reported to be shipments over the Michigan Central and Grand Trunk railways. These figures do not represent the total output of this oil field in 1899. It is reported that most of the refineries at Petrolia closed in April, since which time the bulk of the crude petroleum produced in this field has been piped to the refinery at Sarnia and shipped from there in the refined state.

In the following table is given a statement of the production from 1881 to 1899, based upon the calculations furnished by the customs inspection returns, and the value is computed at the average yearly price per barrel:

Canadian oils and naphtha inspected and corresponding quantities of crude oil.

Year.	Refined oils inspected.	Crude equivalent calculated.	Ratio of crude to refined.	Equivalent in barrels of 35 gallons.	Average price per barrel of crude.	Value of crude oil.
	Imperial gallons.	*Imperial gallons.*				
1881..	6,457,270	12,914,540	100:50	368,987	....	....
1882..	6,135,782	13,635,071	100:45	389,573	....	....
1883..	7,447,648	16,550,328	100:45	472,866	....	....
1884..	7,993,995	19,984,987	100:40	571,000	....	....
1885..	8,225,882	20,564,705	100:40	587,563	$0.82¼	$483,271
1886..	7,768,006	20,442,121	100:38	584,061	.90	525,655
1887..	9,492,588	24,980,494	100:38	713,728	.78	556,708
1888..	9,246,176	24,332,042	100:38	695,203	1.02⅔	713,695
1889..	9,472,476	24,664,144	100:38	704,690	.92¾	653,600
1890..	10,174,894	26,776,037	100:38	795,030	1.18	902,734
1891..	10,065,463	26,435,430	100:38	755,298	1.33¾	1,010,211
1892..	10,370,707	27,291,334	100:38	779,753	1.26¼	984,438
1893..	10,618,804	27,944,221	100:38	798,406	1.09½	874,255
1894..	11,027,082	29,018,637	100:38	829,104	1.00¾	835,322
1895..	10,674,232	25,414,838	100:42	726,138	1.49⅔	1,086,738
1896..	10,684,284	25,438,771	100:42	726,822	1.59	1,155,647
1897..	10,434,878	24,844,995	100:42	709,857	1.42½	1,011,546
1898..	11,148,348	26,543,685	100:42	758,391	1.40	1,061,747
1899..	11,927,981	28,399,955	100:42	808,570	1.48⅔	1,202,020

PRICES.

The average price paid for oil is given in the following table. Sales at the Petrolia Oil Exchange have ceased, producers now making sales direct to the refiners, who own a considerable part of the production.

Average price and sales of crude petroleum in Canada from 1885 to 1899.

Year.	Price.	Sales.	Year.	Price.	Sales.
		Barrels.			*Barrels.*
1885..........	$0.82¼	871,500	1893..........	1.09½	20,941
1886..........	.90	782,570	1894..........	1.00¾	32,348
1887..........	.78	406,203	1895..........	1.49⅔	9,755
1888..........	1.02⅔	516,007	1896..........	1.59	0
1889..........	.92¾	400,932	1897..........	1.42½	0
1890..........	1.18	394,924	1898..........	1.40	0
1891..........	1.33¾	377,453	1899..........	1.48⅔	0
1892..........	1.26¼	165,315			

Average closing prices for crude oil on Petrolia Oil Exchange.

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	$1.30	$1.29¼	$1.18¼	$1.01¼	$1.16	$1.72	$1.50	$1.40	$1.40
February ...	1.28½	1.29	1.18¾	1.01	1.19⅞	1.72	1.50	1.40	1.40
March	1.31¾	1.27¾	1.19	1.01	1.27	1.72	1.50	1.40	1.40
April	1.37	1.26	1.19	.99½	1.55¾	1.72	1.40	1.40	1.43
May	1.37½	1.25¾	1.07	.92	1.67¼	1.70	1.40	1.40	1.45
June	1.37	1.27½	1.07	.92¾	1.52	1.50	1.40	1.40	1.45
July	1.33½	1.26½	1.06	.94	1.54¼	1.50	1.40	1.40	1.45
August	1.34¾	1.26	1.05	.96	1.54	1.50	1.40	1.40	1.46½
September ..	1.35	1.26¼	1.04½	.98	1.55½	1.50	1.40	1.40	1.52½
October	1.35	1.26¾	1.04	1.06	1.59⅞	1.50	1.40	1.40	1.57
November ..	1.33¼	1.25	1.04	1.12¼	1.64½	1.50	1.40	1.40	1.63½
December ..	1.31½	1.18½	1.02	1.13½	1.72⅜	1.50	1.40	1.40	1.66½
The year.	1.33¾	1.26¼	1.09½	1.00¾	1.49⅔	1.59	1.42½	1.40	1.48⅔

IMPORTS AND EXPORTS.

The Statistical Yearbook of Canada, issued by the department of agriculture, Ottawa, Canada, gives the following tables, showing the exports and imports of petroleum:

Exports of Canadian petroleum since 1868.

Year ending June 30—	Quantity.	Value.	Year ending June 30—	Quantity.	Value.
	Imperial gallons.			*Imperial gallons.*	
1868......	46,282	$9,431	1884.......	327,563	$7,546
1869......	690,553	127,319	1885.......	954,966	27,303
1870......	4,748,557	966,461	1886.......	260,449	30,957
1871......	5,753,678	1,052,870	1887.......	310,667	11,151
1872......	7,897,054	1,341,099	1888.......	355,501	66,834
1873......	9,355,325	1,819,183	1889.......	110,470	18,681
1874......	1,276,641	298,417	1890.......	358,804	15,812
1875......	9,844	1,592	1891.......	436,516	18,726
1876......	14,804	3,363	1892.......	440,906	18,217
1877......	3,926,139	900,542	1893.......	178,101	6,814
1878......	73,590	9,423	1894.......	68,740	2,722
1879......	797,079	97,049	1895.......	63,543	3,572
1880......	10,611	1,059	1896.......	18,241	2,971
1881......	2,456	631	1897.......	1,831	230
1882......	662	136	1898.......	*a* 9,530	2,061
1883......	1,422	368	1899.......	4,268	1,194

a Refined only.

Exports of crude and refined petroleum.

Year.	Crude.		Refined.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Imperial gallons.		*Imperial gallons.*		*Imperial gallons.*	
1881	....	....	....	....	501	$99
1882	....	....	....	....	1,119	286
1883	....	....	....	....	13,283	710
1884	....	....	....	....	1,098,090	30,168
1885	....	....	....	....	337,967	10,562
1886	....	....	....	....	241,716	9,855
1887	....	....	....	....	473,559	13,831
1888	....	....	....	....	196,602	74,542
1889	....	....	....	....	235,855	10,777
1890	....	....	....	....	420,492	18,154
1891	446,770	$18,471	585	$104	447,355	18,575
1892	310,387	12,945	1,146	100	311,533	13,045
1893	107,719	3,696	2,196	394	109,915	4,090
1894	53,985	2,773	5,297	513	59,282	3,286
1895	22,831	1,044	10,237	2,023	33,068	3,067
1896	601	101	7,489	999	8,090	1,100
1897	....	....	342	49	342	49
1898	96	4	12,735	3,001	12,831	3,005
1899	0	0	3,425	859	3,425	859

The following table gives the figures of domestic inspected and foreign imported oil since 1882, showing the total quantity of oil consumed in Canada during the period:

Total consumption, Canadian and American oil, 1882 to 1899.

[Imperial gallons.]

Year ending June 30—	Canadian.	American.	Total.
1882	5, 910, 787	3, 026, 186	8, 936, 973
1883	6, 970, 550	3, 088, 414	10, 058, 964
1884	7, 656, 011	3, 148, 920	10, 804, 931
1885	7, 661, 617	3, 813, 379	11, 474, 996
1886	8, 149, 472	3, 803, 724	11, 953, 196
1887	8, 243, 962	4, 309, 397	12, 553, 359
1888	9, 545, 895	4, 493, 924	14, 039, 819
1889	9, 462, 834	4, 723, 698	14, 186, 532
1890	10, 121, 210	5, 075, 650	15, 196, 860
1891	10, 270, 827	5, 321, 524	15, 592, 351
1892	10, 238, 426	5, 793, 636	16, 032, 062
1893	10, 683, 806	6, 249, 946	16, 933, 752
1894	10, 825, 350	6, 666, 323	17, 491, 673
1895	10, 928, 894	6, 752, 425	17, 681, 319
1896	10, 530, 339	5, 804, 067	16, 334, 406
1897	10, 502, 872	5, 665, 204	16, 168, 076
1898	10, 796, 847	6, 880, 734	17, 677, 581
1899	11, 005, 804	8, 176, 216	19, 182, 020

Total amount of oil inspected, Canadian and imported.

Year.	Canadian.	Imported.	Total.	Canadian.	Imported.
	Imperial gallons.	*Imperial gallons.*	*Imperial gallons.*	*Per cent.*	*Per cent.*
1892	10, 370, 707	2, 601, 946	12, 972, 653	79. 9	20. 1
1893	10, 618, 804	4, 520, 392	15, 139, 196	70. 1	29. 9
1894	11, 027, 082	5, 705, 787	16, 732, 869	65. 9	34. 1
1895	10, 674, 232	5, 677, 381	16, 351, 613	65. 3	34. 7
1896	10, 684, 284	6, 106, 032	16, 790, 316	63. 6	36. 4
1897	10, 434, 878	6, 628, 361	17, 063, 239	61. 2	38. 8
1898	11, 148, 348	6, 833, 061	17, 981, 409	62. 0	38. 0
1899	11, 927, 981	8, 176, 216	20, 104, 197	59. 0	41. 0

Quantity and value of petroleum exported from the United States to Canada in year ended June 30, 1899.

Dominion of Canada.	Quantity.	Value.
British Columbia:	*Gallons.*	
Naphtha	29,697	$2,799
Illuminating oil	676,744	56,816
Lubricating oil	44,623	12,106
Total	751,064	71,721
Nova Scotia, New Brunswick, etc.:		
Naphtha	3,445	440
Illuminating oil	2,193,952	168,859
Lubricating oil	131,562	22,430
Total	2,328,959	191,729
Quebec, Ontario, Manitoba, etc.:		
Crude	20,510	1,420
Naphtha	121,373	9,450
Illuminating oil	6,292,622	338,717
Lubricating oil	705,740	89,590
Total	7,140,245	439,177
Grand total	10,220,268	702,627
Crude	20,510	1,420
Naphtha	154,515	12,689
Illuminating oil	9,163,318	564,392
Lubricating oil	881,925	124,126

Quantity and value of petroleum exported from the United States to Dominion of Canada from 1871 to 1899.

Year ending June 30—	Oils, mineral, refined.									
	British Columbia.		Nova Scotia, New Brunswick, and Prince Edward Island.				Quebec, Ontario, Manitoba, and Northwest Territory.			
	Refined, including residuum.		Illuminating.		Lubricating.		Illuminating.		Other, including residuum.	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*
1871	....	....	....	....	....	....	160,971	50,755	7,408	1,931
1872	....	....	....	....	....	....	177,006	57,826	104,897	16,321
1873	24,658	10,530	171,297	49,923	29,178	12,649	38,543	12,029	37,071	9,178
1874	30,970	12,106	434,408	95,028	4,075	1,970	74,979	16,769	128,918	14,333
1875	25,659	10,491	513,530	76,592	22,433	11,268	104,456	16,948	50,998	6,770
1876	53,060	19,183	406,751	64,149	13,770	8,967	138,845	18,440	30,315	8,931
1877	47,942	21,030	381,698	87,141	22,973	11,886	125,838	29,346	55,150	20,175
1878	63,932	25,164	780,390	128,391	21,547	10,420	177,320	27,513	78,960	16,262
1879	78,475	25,901	682,545	87,063	32,650	11,615	140,265	19,237	53,239	7,711
1880	76,905	21,043	536,950	61,719	29,910	8,279	124,690	16,396	88,619	10,415
1881	74,595	19,489	704,841	100,517	32,850	9,646	447,446	63,091	59,969	7,992
1882	139,334	34,046	1,169,647	136,864	32,265	11,492	1,559,224	171,181	114,327	25,521
1883	92,893	20,732	1,243,996	140,918	43,986	15,831	1,554,760	178,623	224,621	55,070
1884	140,275	34,177	1,365,842	143,187	46,000	14,704	1,256,469	142,913	158,653	37,194
1885	191,074	43,274	1,661,740	166,317	69,427	17,953	1,575,933	159,569	142,360	29,200
1886	207,933	42,487	1,755,526	182,462	54,424	16,466	1,165,996	129,323	512,052	108,392
1887	236,011	49,200	2,046,721	195,163	52,500	14,026	2,074,351	204,750	181,303	32,176
1888	219,753	42,806	2,042,463	191,136	73,779	17,528	2,399,687	226,962	131,027	36,560
1889	317,304	61,348	2,065,638	209,964	105,220	29,521	2,470,421	212,105	184,224	50,268
1890	293,004	55,686	2,198,385	222,608	163,444	33,002	2,128,453	197,229	112,433	27,334
1891	332,510	70,903	2,449,254	243,414	168,224	34,307	1,911,067	189,032	161,069	29,652
1892	333,476	62,091	2,687,884	259,363	112,457	24,217	2,159,331	181,795	140,732	21,979
1893	325,799	62,132	2,653,653	247,561	199,574	39,195	2,586,671	213,894	262,672	41,739
1894	628,239	73,802	994,911	92,592	146,468	24,612	6,070,979	332,142	910,683	128,793
1895	599,144	69,308	622,361	53,772	96,732	20,366	6,006,309	308,907	728,752	99,372
1896	581,997	74,281	1,359,418	110,440	93,508	18,721	6,630,733	417,234	802,968	97,295
1897	650,885	63,444	1,230,078	102,880	124,561	23,344	6,587,984	386,593	704,241	85,228
1898	772,421	61,477	1,307,388	104,754	105,011	21,498	7,337,152	405,731	926,705	98,146
1899	751,064	71,721	2,193,952	168,859	131,562	22,430	6,292,622	338,717	847,623	100,460

THE GASPÉ BAY OIL FIELD.

In 1889 a company of London capitalists, known as the Petroleum Oil Trust Company, began drilling for petroleum near the northeastern extremity of the great Appalachian range of mountains, which terminates in Gaspé district, Province of Quebec. The surface rocks are the Devonian, Silurian, and Cambro-Silurian. There is also a fringe of carbonaceous rocks on the ocean front. These rocks are tilted at considerable angles and are more or less folded.

Since 1889 this company has drilled 33 wells, and more or less oil is reported to have been found in all except one. Several wells were drilled in 1899. A sample of petroleum found in one of these wells has been analyzed, and the result shows it to be first-class crude petroleum. Many of these wells have been drilled to a depth of from 2,500 to 3,800 feet.

The London company has lately been reorganized and is now known as the Petroleum Trust Company.

A pipe line 12 miles long to the harbor was finished during the year, and material for a refinery is reported to be upon the ground. The petroleum is believed to be found in the Lower Silurian formation, but the quantity so far developed has been comparatively insignificant.

NEW BRUNSWICK.

A party of geologists under Professor Shaler, of Harvard College, at Cambridge, Mass., made an examination of a considerable section of this country south and east of Moncton. Two wells were drilled in 1898. One, at Dover, 7 miles from Moncton, went down 1,400 feet, and another, 1,000 feet deep, which gave some slight indications of petroleum, was drilled on the divide toward Memramcook.

The parties engaged in this work have secured a large number of leases and are making arrangements to make further tests. There are large deposits of shales rich in oil and paraffin in Albert and Westmoreland counties. In the former county the celebrated Albert mine furnished a mineral rich in hydrocarbons and was worked for several years, but is now abandoned.

NOVA SCOTIA.

We give the following extract from a report on New Mineral Discoveries in Nova Scotia, by Edwin Gilpin, jr., A. M., LL. D., inspector of mines, Halifax, Nova Scotia:

OIL SHALE IN CAPE BRETON.

Experiments have been made recently on the oil values of some shale deposits in Cape Breton County. At Macadams Lake, on the north side of East Bay, the Lower Carboniferous measures rest on Silurian and pre-Cambrian strata. Here a number of beds of black lustrous shale are found associated with conglomerates, gray shales, and sandstones, pitching heavily to the south, away from the older rocks. These black shales are so highly charged with carbonaceous matter as to be capable of combustion. Explorations have shown a number of beds of this character from 2 to 10 feet in thickness, extending for several miles in an easterly and westerly direction.

The following results are stated to have been obtained from working tests. The distillation in retorts yields, besides a little water, a quantity of heavy oil, a little gas, and coke available for fuel. The yield of oil is from 15 to 20 gallons per ton of 2,000 pounds. In refining this crude distillate the product may be divided into different varieties, according to the market. A convenient division yields 20 per cent kerosene, 20 per cent white spindle or sewing-machine oil, 40 per cent heavy lubricating oil, and 20 per cent pitch.

The kerosene does not differ materially from ordinary American petroleum kerosene. It refines white and is very free burning. White spindle oils are the most costly in the market. There are none, however, in the United States obtained from petroleum so white and so heavy as this from East Bay. The lubricating oil is heavy, while it is as light in color as the heaviest paraffin oil in America. The yield of crude oil is found to be about 6.25 per cent, and the proportion per ton would be—

	Per cent.
Kerosene oil	1.25
White spindle oil	1.25
Heavy lubricating oil	2.50

	Per cent.
Pitch	1.25
Water	5.75
Coke	87.50
Loss (gas, etc.)	.50
Total	100.00

It is also ascertained that this material is readily distilled and refined by methods and apparatus in general use in shale and petroleum industries in Great Britain and the United States. The pitch is of good quality.

If these statements are verified by actual practice and the costs permit, a large and important industry may be counted on here. Should these oils find a market and demand abroad, no doubt the shales in various parts of the province known to be bituminous will receive attention.

During the summer of 1898 a deep well was drilled by Boston capitalists on the west shore of Lake Ainslie, Cape Breton. It went through a number of sandstone strata and shales closely resembling those found in the petroleum region of Pennsylvania. Another well was drilled in 1899 not far distant from the first. A third well was drilled on the east side of the lake, but no petroleum or natural gas was found. Many years ago seven wells were put down on the west side of the lake from 400 to 800 feet in depth, and a small quantity of very heavy black petroleum was obtained. There are two points on the lake where petroleum has been found in small quantities coming up through the water. There are likewise several places where the escape of natural gas causes some ebullition in the water. There are numerous outcrops of the subcarbonaceous limestone, and pieces of the rock, when freshly broken, reveal a strong odor of petroleum. There are several points on the waters of Bras D'Or Lake at which slight showings of petroleum are reported.

NEWFOUNDLAND.

Very little remains to be added to the information contained in the previous report for this section. It is reported that the English syndicate, which controls most of the section at Parsons Pond, will put down a number of deep wells the coming year. In the extreme southern portion of the developments at Shoal Point, Port Au Port Bay, on a narrow projecting point of land four wells were drilled in 1898. In three of these petroleum in moderate quantities was found at depths ranging from 136 to 680 feet. During 1899 another well struck petroleum at 190 feet in depth and made 10 barrels in eleven hours. The company developing this section is at present engaged in sinking a deep well. The petroleum found on the northwest coast of Newfoundland has been developed at intervals over an area 125 miles in length, with an average width of 10 miles. The formation holding the petroleum belongs to the Quebec group, and is interesting because it is the lowest division of the geological scale that has produced petroleum in any quantity. The Chazy and Trenton limestones are both found

above. The formation holding the petroleum is made up of a series of thin-bedded shales and sandstones, with some thin seams of limestone. The strata stand at highly inclined angles, and at points overturned anticlinals and duplications have been observed.

The color of this petroleum is of a dark amber, the gravity ranges from 33° to 36°, and it possesses good lubricating qualities. There are many fine bays along the coast in the southern portion of the area above described, but in the northern portion there is but one, and the anchorages are poor.

GREENLAND.

Mr. Langdon Gibson, of Peary's first polar expedition, in 1890, reports the finding of a petroleum spring at McCormick Bay, on the western coast of northern Greenland, in 78° north latitude. The spring is near the level of the sea, above which the rocks towered 1,000 feet or more.

PERU.

The production of crude petroleum in Peru for 1899 was 3,745,000 gallons, or about 900,000 barrels, an increase of 865,000 gallons, or about 41,000 barrels, over 1898. The refined products for illuminating increased 200,000 gallons. The great increase was in the lubricating oils, which increased 1,291,000 gallons, doubling the production of 1898. Benzine increased 3,000 gallons. The manufactured products amount to 3,359,000 gallons, leaving only 386,000 gallons to be sold as fuel oil, residuum, etc.

The imports of illuminating oil from the United States decreased 268,410 gallons, while the lubricating oil increased 4,928 gallons, during the past year. Three companies continue to operate this field; they are the London Pacific Company (British), Faustino G. Piaggio Company (Italian), and the Compagnie Française (French). The holdings of these companies were fully described in the report for 1898.

The large percentage of carbon in this and the California petroleum take them out of the line of competition with the illuminating oils of the eastern United States. A good quality of lubricating oil and naphthas is made from the Peruvian petroleum.

The scarcity of other fuel along the Pacific coast ought to make a market for the natural petroleum and a large part of the residuum after a portion of the lighter products have been taken out. It has already found a market for the reduction of the silver ores mined at Casapalca, and it is almost an ideal fuel in the reduction of zinc and copper ores, which are found in this country. It has also been used with good success on the Oroya Railroad. Residuum that has a fire test of not less than 250° F. and where the price and quantity can be assured is the ideal fuel for ocean and river vessels.

The following statement of the production of petroleum in the Zorritos oil field of Peru has been furnished by Mr. Faustino G. Piaggio, who is operating in that field:

Production of petroleum in Zorritos oil field of Peru from 1896 to 1899.

Year.	Crude petroleum.	Refined.	Lubricating oil.	Benzine.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
1896	1,996,520	608,900	896,450	4,560
1897	2,874,980	959,645	964,680	7,940
1898	2,880,000	600,000	1,250,000	8,350
1899	3,745,000	806,900	2,541,000	11,220

Quantity and value of mineral oils exported from the United States to Peru, 1871 to 1899, inclusive.

Year.	Oils, mineral, refined.			
	Illuminating.		Lubricating.	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*
1871	359,846	104,923	....	....
1872	303,389	89,162	4,254	1,574
1873	208,110	63,563	5,168	3,989
1874	257,230	55,074	2,293	1,335
1875	515,331	102,263	2,700	1,730
1876	242,807	45,482	2,382	1,008
1877	316,635	72,252	753	423
1878	513,534	86,417	2,290	1,635
1879	561,115	76,589	2,720	945
1880	145,682	12,933	5,639	2,251
1881	113,000	13,805	503	125
1882	287,500	33,131	7,958	2,586
1883	421,300	45,266	1,949	806
1884	295,909	30,210	8,705	3,480
1885	337,455	31,490	7,603	2,883
1886	602,618	56,084	13,590	3,945
1887	195,290	19,436	5,189	2,086
1888	441,621	43,965	9,672	3,796
1889	425,055	46,927	21,524	10,238
1890	201,980	24,105	39,998	14,368
1891	319,574	37,713	39,107	15,250
1892	279,435	26,685	32,437	12,160
1893	292,765	26,008	22,359	6,664
1894	387,620	32,832	44,239	13,713
1895	269,020	27,048	34,191	10,900
1896	503,510	57,384	65,868	16,778
1897	580,850	64,045	63,736	15,786
1898	590,460	53,524	65,342	18,484
1899	321,950	33,846	70,270	17,114

MEXICO.

The existence of asphalt and petroleum has long been known in Mexico, and the States that border on the Gulf have deposits of both. The States of Tamaulipas, Vera Cruz, Tabasco, and Yucatan, as well as the State of Oaxaca, on the Pacific coast, are known to contain deposits of petroleum. In northern Vera Cruz, 40 miles from the coast, several wells have produced petroleum in a limited way for the past six years. During 1898 an American company commenced active operation at Espinal, in the northern part of the State of Vera Cruz.

All the petroleum so far discovered seems to have an asphalt base, which unfits it for making an illuminating oil. In the absence of any extensive deposit of coal so far developed, a large supply of this liquid fuel would find a ready market.

The high tax on manufactured oils derived from petroleum levied by Mexico, as compared to the comparatively low tax levied on crude petroleum, causes the latter to be shipped in bulk in vessels to Tampico and Vera Cruz and by railroad to the City of Mexico, and at all three of these points extensive refineries exist.

Trade in petroleum and allied products for the financial year 1898–99.

[The duty is on a unit of 1 kilogram weight in Mexican silver, now at $23\frac{7}{16}$d. per dollar.]

Description.	Quantity.	Value.*a*	Customs duty.
	Kilos.		
Oil, crude	25,750,397	$421,677	$0.03
Oil, refined	1,090,919	52,457	.10
Wax, mineral	77,658	15,250	.10
Paraffin, in bulk or blocks	3,111,956	260,435	.10
Paste, mineral, for lubricating	5,077	1,327	.10
Vaseline	44,880	7,330	.10
Total	30,080,887	758,476	....

a Kilo weighs about 2.2 pounds, and a gallon of refined oil weighs about 6.6 pounds, so that there are 3 kilos in 1 gallon. As the duty is 10 cents per kilo, it will be 30 cents per gallon. That on crude would be only 7½ cents per gallon. A gallon of crude weighs about 7.2 pounds.

The following table shows the prices for petroleum products at Mexican refineries during 1899:

Prices of petroleum products at Mexican refineries.

Location.	Illuminating oil.	Lubricating oils.			Paraffin wax.
		Machinery.	Cylinder.	Car.	
	Per liter.	*Per liter.*	*Per liter.*	*Per liter.*	*Per kilo.*
Vera Cruz	$0.13½	$0.20½	$0.26½	$0.14½	$0.53
Tampico	.14	.21½	.25½	.16	.53¾
Mexico	.15	.21½	.26	.18	.53¼

The exports of petroleum and its products to Mexico for the year ended June 30, 1899, as reported by the United States Treasury, are given in the following table. The figures are very close to those reported for the year ended June 30, 1898. If a gallon of crude weighs on the average 7.2 pounds, this amount divided by 2.2 pounds, the weight of a kilogram, will give 3.27 kilograms to 1 gallon of crude. This amount multiplied by the gallons reported exported gives 26,061,500 kilograms, which is only slightly over that reported at the close of 1899, in the former table.

Exports of petroleum and its products from United States to Mexico, year ended June 30, 1899.

Kind of oil.	Gallons.	Value.
Crude	7,969,871	$395,386
Naphtha	73,405	14,169
Illuminating	581,222	73,312
Lubricating	605,249	103,999

CUBA AND PORTO RICO.

For many years extensive deposits of bitumen have been known to exist in Cuba. It is made use of to some extent as a fuel. Illuminating gas, which supplies the town of San Juan, is also manufactured from it. Several wells of moderate depth have produced a remarkably light natural naphtha, which is thought to have originated in the natural distillation of bitumen by internal heat. A well drilled in the province of Santa Clara, on the Montembo estate, at a depth of 95 meters, found a small deposit of pure naphtha; it was as colorless and transparent as distilled water, of a density of .754, and was a solvent for all gums that are dissolved by naphtha. Other localities have produced a somewhat similar material.

Were it not for the very large and easily accessible deposit of asphalt on the neighboring island of Trinidad, the deposits of asphalt known to exist in Cuba would find a market.

There are about three barrels of crude petroleum imported into Cuba to one of refined oil. This is owing to a high import duty on refined oil, amounting to $4.70 per 100 kilograms, or 220 pounds, or $5.87 per barrel of 42 gallons. The duty on crude petroleum imported is $1.40 per 100 kilograms, which amounts to $1.95 per barrel of 42 gallons.

During the year 1899 there was a marked increase in the importation of illuminating oils and a slight falling off in the crude imported as shown in the following table.

There is a large and complete refinery at Habana, in which the crude arriving in bulk is converted into marketable products and distributed over the island.

The export to Porto Rico is almost entirely illuminating oil. As shown in the following table, it is comparatively small, although larger in 1899 than for several years past.

Quantity and value of mineral oils exported from the United States to Cuba and Porto Rico, 1871 to 1899, inclusive.

Year.	Cuba.				Porto Rico.	
	Crude.		Refined.		Illuminating.	
	Gallons.	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*
1871....	306, 799	55, 845	1, 696, 114	445, 929	101, 139	29, 993
1872....	328, 695	53, 493	1, 495, 494	425, 045	209, 947	63, 153
1873....	734, 283	156, 243	1, 272, 156	350, 117	200, 885	59, 621
1874....	885, 537	131, 291	1, 548, 741	328, 163	270, 327	57, 328
1875....	1, 172, 768	141, 859	1, 405, 787	223, 697	256, 319	45, 448
1876....	624, 539	90, 067	2, 091, 335	341, 854	234, 121	41, 576
1877....	408, 819	73, 659	2, 338, 165	527, 807	278, 243	64, 431
1878....	1, 205, 984	158, 533	1, 362, 512	233, 320	291, 843	48, 674
1879....	1, 805, 491	201, 770	724, 802	100, 928	265, 570	32, 667
1880....	1, 662, 173	152, 868	888, 530	97, 938	333, 545	34, 925
1881....	1, 358, 995	132, 709	866, 449	113, 012	271, 928	36, 481
1882....	2, 053, 792	191, 906	2, 147, 369	223, 248	555, 460	64, 119
1883....	2, 763, 844	238, 731	509, 318	78, 148	291, 834	36, 310
1884....	3, 054, 681	288, 587	333, 200	74, 569	501, 638	59, 052
1885....	2, 991, 202	223, 302	624, 085	90, 680	466, 699	49, 738
1886....	4, 091, 056	335, 307	560, 110	95, 856	513, 800	54, 787
1887....	3, 901, 600	260, 965	1, 334, 480	154, 618	538, 100	62, 679
1888....	4, 039, 633	289, 513	1, 218, 626	138, 965	567, 365	72, 946
1889....	3, 643, 233	296, 804	1, 335, 749	107, 552	816, 458	96, 763
1890....	4, 913, 330	446, 618	2, 057, 541	149, 096	123, 251	131, 433
1891....	3, 300, 455	280, 144	1, 328, 760	96, 131	64, 269	8, 966
1892....	6, 316, 406	378, 216	609, 808	101, 126	708, 488	64, 219
1893....	6, 955, 315	403, 310	606, 015	111, 498	480, 390	40, 927
1894....	6, 865, 549	413, 140	511, 771	111, 877	171, 446	16, 565
1895....	6, 980, 372	451, 443	202, 744	44, 856	323, 700	32, 605
1896....	4, 838, 657	330, 598	66, 088	18, 147	241, 692	30, 732
1897....	4, 772, 589	296, 849	68, 747	10, 067	268, 020	30, 713
1898....	3, 829, 463	207, 649	243, 202	31, 358	198, 390	22. 122
1899....	3, 297, 175	192, 686	*a* 1,086,309	125, 156	*b* 538, 712	57, 163

a CUBA:

Refined.	Gallons.	Value.
Naphtha	2, 064	$454
Illuminating	802, 518	75, 318
Lubricating	281, 727	49, 384
Total	1, 086, 309	125, 156

b PORTO RICO:

Refined.	Gallons.	Value.
Naphtha	2, 590	$441
Illuminating	538, 712	57, 163
Lubricating	13, 348	3, 411
Total	554, 650	61, 015

ECUADOR.

Petroleum was found by a priest during the last century on the north shore of the Gulf of Guayaquil, in Ecuador. Deposits are also found on the shores of the Pacific, and in many places signs of a liquid bituminous substance are found in schist. The oil-bearing formation stretches back quite a distance from the ocean. At numerous points, by digging down 3 or 4 feet into the earth, a dark, brown, sandy clay is found, which is saturated with salt water and petroleum. At St. Paula a number of shallow wells furnish considerable petroleum.

ARGENTINA.

Petroleum is found on the east slope of the Andes Mountains, in southwestern Argentina, not far from the town of Mendoza, and also at other places in the Republic.

It is used principally for locomotive fuel.

Petroleum springs are found in Garrapatal, La Brea, and Vachenta.

COLOMBIA.

Numerous natural springs of petroleum are reported in Colombia. They occur on the Rio Arboledas, near the mouth of the Magdalena River, and on the Usada River, near Curbarador.

VENEZUELA.

Petroleum and asphalt are found in Venezuela, in the neighborhood of Lake Maracaybo, in the northwestern portion of the Republic and on the Tarra River. Southwest of Lake Maracaybo numerous springs of petroleum are reported.

PETROLEUM FOR FUEL PURPOSES.

The following extracts are taken from a paper written by Mr. H. Tweddle for the Engineering and Mining Journal, and are valuable to all interested in the comparative value of petroleum and residuum as a fuel:

Crude petroleum is a hydrocarbon, often containing a small percentage of sulphur and oxygen as impurities. Its specific gravity may vary from 12° to 70° Baumé, but the greatest quantity produced ranges from 30° to 45° Baumé. The color of crude petroleum is usually a green brown, but it is found from a light brown color, through the various shades of green, to a jet black. Colorless petroleum has been found in a natural state, but only in small quantity and of light gravity. It is the result of a natural distillation in the bowels of the earth.

Crude petroleum may be broken up by distillation into benzine, kerosene, and other distillates and residuums of various qualities, any one of which makes a very good fuel under certain conditions. To a misunderstanding of these conditions is due much of the adverse criticism of the use of oil as fuel that has appeared of late years, and to an appreciation of these conditions and of the special qualities of each of the products of petroleum will be due the success that this class of fuel will achieve. These products and their qualities may be:

Gasoline, or petroleum distillate of more than 74° Baumé (sp. gr.), will never be used for fuel except to a very limited extent, since it and its closely associated dis-

tillates are always more valuable for other purposes, and it is but poor economy to burn them under a boiler when it will give so much better results when used directly in the cylinders of the engine.

Benzine, or petroleum distillate from 55° to 74° Baumé, is the best of all liquid fuels, but its use is restricted, owing to the care with which it has to be handled. The difficulty, danger, and expense of transporting will only allow of its use in a very few favored localities. It will probably be used more extensively for enriching gas and for small portable motors.

Kerosene, or petroleum distillate of from 48° Baumé to 35° Baumé gravity, is an excellent fuel, but, owing to the expense attending its preparation, we can hardly expect to see the price fall below 3 cents per gallon except in the places where it is produced; for, should it generally become so cheap, the consumption of it as an illuminant would increase so enormously that there would be little left for fuel.

The present price of kerosene in bulk and in large quantity may be taken at about 3 cents per gallon at its place of production, both in Russia and America. As a fuel for small boilers it is the best, because of its portability and the safety and facility with which it can be handled. Any one who has seen one of the many systems of small kerosene engines and boilers now in vogue in the United States will marvel that so especially neat, automatic, and economical a motor has not been more generally introduced.

Next to kerosene, some of the heavy distillates of petroleum known as neutral or solar oils could be used as fuel, but they have no particular advantage over kerosene save their high fire test.

Crude petroleum may contain any portion of benzine and kerosene from nothing up to nearly 90 per cent, varying entirely with the locality where it is produced. However, we may say roughly that, of these two distillates, American crude petroleum contains 50 to 75 per cent of kerosene and benzine; Russian, from 15 to 50 per cent; Peruvian, from 15 to 50 per cent.

If distillation is stopped after the benzines and kerosenes have been run off, there remains in the still an oil known by the various names of residuum, reduced oil, tar, fuel oil, astatki, mazoot, petroleum refuse, etc. In speaking of these we shall employ the term "residuum."

Crude oil is a most excellent and easily handled fuel, but it must be used with caution, and is absolutely unfit for use on a locomotive or steamer, since, in case of accident, it may catch fire and spread with the startling and deadly rapidity which only those who have seen a petroleum fire can realize.

The petroleum fields of Peru somewhat resemble those of California, and are most favorably situated close to the sea and under climatic conditions that are enjoyed in but few places, and the few wells drilled have been productive. The crude oil is a good fuel for stationary boilers, and, if 40 per cent of benzine and kerosene are distilled off, the resulting residuum is an oil of about 22° Baumé gravity and 260 to 280° fire test, of moderate viscosity and containing no paraffin. It preserves its fluidity at low temperatures, and makes an excellent fuel for either locomotive or marine use. The price at which it can be supplied is 20s. to 30s. per ton. As good coal on the west coast of South America seldom reaches a lower figure than 25s. per ton, this fuel oil will be able to compete with it from an economic point of view, so soon as a sufficiently large supply of it is guaranteed.

There also exists on the high table-land between the two chains of the Andes in Peru a yet untouched petroleum deposit in very favorable geological surroundings. The neighboring region is very metalliferous, but without fuel. Once the supply of fuel solved, the development of the mineral wealth is assured.

It is not the writer's object to review the various methods that have been or are now in use for burning petroleum, but, believing more in practice than in theory, and that the simplest and most economical system is the best, he will limit himself to a description of those methods that have shown these qualities.

Petroleum is a liquid hydrocarbon—that is, it is a compound of hydrogen and carbon in varying proportions. One pound of carbon, when completely burned, yields 14,500 heat units, each of which is equal to 772 foot-pounds of energy; by this we mean that one pound of carbon oxidized to form CO_2 (carbonic acid) will give off during the combination 14,500 heat units, and will require the amount of oxygen contained in 12.13 pounds of air to completely burn or oxidize it. If we allow just the right proportion of air to mix with the burning carbon, we get a most intense heat, which is supposed to be about 4,580° Fahrenheit. If, however, we allow too much air to reach the carbon, the number of heat units given off is the same, but the temperature is reduced, because part of the heat is absorbed in warming the excess of air.

For our purpose we will consider that the air consists of oxygen and nitrogen in the proportion of 8 to 28. Therefore for each part of oxygen which combines with the carbon 3½ parts of nitrogen must be heated. This is pure waste. The nitrogen of the air serves no purpose in burning except to lessen the intensity of the heat. Were it possible for us to combine carbon with undiluted oxygen, the intensity of combustion would be raised enormously—in fact, so much that boilers could hardly be built to stand the heat.

If we do not allow sufficient oxygen to reach the carbon, the latter will not oxidize to CO_2, but only to CO (carbonic oxide), and will give out much less units of heat. Here, then, is the great difficulty. To get the maximum efficiency of carbon as fuel we must admit just enough oxygen under the form of atmospheric air to allow of complete oxidation; if too little is admitted, we do not liberate all the heat units; if too much is admitted, it acts as a dilutent, and the total useful efficiency is greatly diminished.

One pound of carbon would, if all its heat were utilized, exert 5.67 horsepower for one hour, instead of from one-half to one-fourth horsepower, which is the result obtained in the best ordinary practice. The same pound of carbon would, if all its heat were utilized in a boiler, evapororate 15 pounds of water from 212° at atmospheric pressure. The average evaporation of boilers now in use only utilizes about one-half of this heat, either from bad design or from poor stoking. Not to mention the fact that any accumulation of scale in the interior or of soot on the exterior seriously affects the efficiency of the boiler, one-eighth inch of a deposit of soot renders the heating service practically useless, while one-sixteenth inch of scale or sediment will cause a loss of over 10 per cent in fuel.

Hydrogen is also a fuel, and the best of all, since one pound of hydrogen requires the oxygen contained in 36 pounds of air to effect its complete oxidation, during which it gives off 62,032 units of heat, and the temperature of combustion is much higher than that of carbon. The result of the oxidation of hydrogen is to form H_2O, or water.

Sulphur is also a fuel, but a poor one, as it only gives out 4,000 units of heat on oxidizing, but as the quantity of sulphur contained in petroleum is so small it may be disregarded for all practical purposes.

We have here our two useful fuels, namely, carbon and hydrogen, and any other element which may enter into their composition is a detriment. Knowing the chemical constituents of our fuel, we can easily calculate its theoretical efficiency. In order to reach as near the theoretical efficiency as possible in practice we must supply the right amount of oxygen or air, and in the properly regulated admission of air is where liquid fuel has its great superiority over solid.

It must be remembered that the presence of oxygen in fuel is harmful, not only because it does not serve to increase the heat, but it has weight, which must be paid for when the fuel is purchased, and must be carried to serve no useful purpose, since the oxygen required for combustion is furnished free of cost from the air and does not have to be carried or handled.

Annexed will be found a table of combustibles, which will allow the reader to appreciate more fully what has been written above.

In order to allow the right amount of air to reach the combustible employed, various methods have been used, the best of which is to turn the combustibles or fuel into gas, which is under complete control and can be easily regulated. Next to this is liquid fuel, which has all the advantages of gaseous fuel, since it can be changed to gas at the moment of admission to the furnace, is under the same easy control, and has the extra advantage of flowing more easily through pipes of less diameter and requiring much less space for storage. After liquid fuel pulverized solid fuel is the best, since it admits of being intimately mixed with air and being injected into the furnace much in the same style as a liquid fuel.

Table of combustibles.

Kind of combustible.	Air required per pound of combustible.	Temperature of combustion.			
		With theoretical supply of air.	With 1½ times theoretical supply of air.	With 2 times theoretical supply of air.	With 3 times theoretical supply of air.
	Pounds.	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*
Hydrogen	36	5,750	3,860	2,860	1,940
Carbon	12.13	4,580	3,215	2,440	1,650
Wood (air dried)	4.80	3,700	2,607	2,100	1,530
Petroleum	15.43	5,050	3,515	2,710	1,850

Kind of combustible.	Theoretical value.		Highest attainable value under boiler.	
	Water raised 1° per pound of combustible.	Water evaporated from and at 212° with 1 pound of combustible.	Water evaporated at 212° with chimney draft.	With blast theoretical supply of air at 60°, gas at 320.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Hydrogen	62.032	64.20		
Carbon	14.500	15	13.30	14.14
Wood (air dried)	7.249	7.50	6.64	7.02
Petroleum	21.000	21.74	18.55	19.90

NOTE I.—On an average 1 pound of coal is equal in steam-making capacity to 2 pounds of dried peat; 2 to 2½ pounds of dried wood; 3 pounds of dried tan bark or bagasse; 3½ pounds of straw; 5 to 8 pounds of wet tan bark or bagasse.

NOTE II.—With chimney draft, experiments show that about twice the theoretical amount of air to secure perfect combustion is used in the United States Navy, and about three times as much in the ordinary run of boilers.

NOTE III.—The relative value of fuels is largely a question of locality and transportation. In the Tropics precious woods are burned, since they are the cheapest, and during a coal famine in the Western States the most available fuel was indian corn. Natural gas varies in its composition, but is usually worth from 2 to 2½ times its weight of coal, or about 30,000 cubic feet to the ton.

In 1890 the writer introduced petroleum fuel on the Oroya Railroad in Peru, where the conditions were very severe. This railroad starts from sea level at Callao and crosses the Andes at an elevation of over 14,000 feet, with a total length of about 100 miles. On April 30, 1890, the first regular passenger train in South America pulled

by an oil-burning locomotive was hauled up to Verrugas, 5,800 feet above sea level, arriving on schedule time. From then till September of the same year, when the new fuel was definitely approved, an engine ran regularly on the mountain service without a breakdown. Against her was run a sister locomotive burning coal. Running for five months, pulling equal trains over the same track, the locomotives furnish the best competitive test of practical oil and coal burning on a railway.

Engine No. 1 ran with coal, engine No. 15 with petroleum or fuel oil. Both engines were exactly alike in other respects, being American Rogers, mogul type, with 47-inch drivers, 18 by 24 inch cylinders; total engine weight, 38 tons; tender, 28 tons. Regular train hauled was 5 cars, with an average weight of 18 tons each. Total weight of train was 118 tons. Eight and 10 cars were sometimes taken as far as Chosica, from where the 3 and 4 per cent grades began.

The grades and distances as far as Verrugas are as follows:

Distances from Callao, Peru, to points on Oroya Railroad.

Station.	Distance from Callao.	Height above sea level.	Average grade.
	Miles.	*Feet.*	
Callao	0	0	
Lima	8½	448	1 in 100
Santa Clara	18¼	1,312	1 in 60
Chosica	33½	2,832	1 in 53
San Bartoleme	47	4,919	1 in 34
Verrugas Bridge	51¾	5,840	1 in 27

Among heavy grades may be mentioned: Between Chosica and San Bartoleme, one grade 4.2 per cent, another 4 per cent, combined with a 274-meter radius curve, and, again, 3 kilometers before San Bartoleme a grade of 3.92 per cent, combined with a 113-meter radius curve.

As to the behavior of the No. 15 on these heavy grades, the steam gauge always recorded from 135 to 140 pounds, never falling below 135 pounds. As a rule the pointer stood at 140 pounds, and although the safety valve would blow off at 142 pounds, so admirably was the fire at all times under control that it very rarely blew off. On grades up to 3 per cent no smoke whatever showed from the funnel. On the 4 per cent grades a slight hazy smoke would show at times. The average consumption of coal for the month was 79.30 pounds per train mile. The average consumption of fuel oil per train mile was 38.55 pounds, or slightly less than 50 per cent of the coal used.

The explanation of this lies in the regular feeding of fuel where a liquid is used, as compared with the irregular and wasteful coal stoking. Again, on the heavy grades the sharp, strong exhaust carries a large percentage of the smaller coal out of the funnel unconsumed.

SAFETY OF LIQUID FUEL OF HIGH FIRE TEST.

Residuum oil which has a fire test of, say, 250° to 300° F. is the most suitable for fuel on steamers, since it is absolutely safe, as it can not take fire and does not give off inflammable gases until heated to a temperature above that of boiling water. As the fuel would be carried in tanks below the water line, heating to that degree becomes a practical impossibility. Such oil may be placed in a bucket and stirred with a red-hot poker without catching fire; shovelfuls of hot coal may be

thrown into it, but they will sink and be extinguished the same as if thrown in water. It has been said that petroleum is dangerous as a fuel for steamers. I answer that it all depends upon the kind of petroleum. It would be foolhardy to use a low-test petroleum on steamers, and dangerous to use even a medium-test oil, such as kerosene, but, as before stated, high-test oils are absolutely safe.

Notwithstanding that the greatest drawback in vessels of war is their limited stowing capacity for fuel, it has been urged that substituting liquid fuel for coal on navy vessels would weaken their protection, insomuch as the coal bunkers are so arranged that their contents protect the vitals of the ship. This is, however, rather a weak argument, since the protection is only given when the bunkers are full, and the probabilities are that naval engagements will not always be fought immediately after the vessel has been fully coaled; and once the coal is used from the upper part of the bunkers this protection disappears and an empty space is left, which more than likely would contain gases that might be dangerous in case of a shell exploding in them. It is still an open question whether bunkers should be ventilated, especially when freshly mixed damp coal is used, since the moisture present in coal is a measure of its absorptive power, and the more absorptive coal is the more dangerous.

For marine purposes the advantages are still more obvious, since the fuel tanks may be in any part of the ship and subdivided to any extent. For instance, the writer has often used the ballast tanks for carrying fuel oil, and these once emptied of oil can be filled with water should the trim of the ship require it, or by a simple turning of valves the fluid may be transferred from one end of the ship to the other without expense or labor. For instance, in modern vessels the ballast tanks have a capacity of from 10 to 20 per cent of the whole vessel and they are perfectly useless for other purposes save to carry extra feed water for the boilers. In case they were completely used for fuel oil the feed could be made up by the use of evaporators.

The disagreeable, dirty, and lengthy process of coaling is done away with, and instead of having to hang awnings and cover up machinery to prevent the entrance of dirt and grit all that is necessary is to make a flexible hose connection with a shore pipe and the liquid fuel is pumped on board in a fraction of the time that coaling would take.

Extra facilities are required to load steadily 100 tons of coal an hour and in large steamers stowing, say, 3,000 tons of coal, the loading generally takes two days, some forty to fifty men being employed in handling and distributing it, the cost running from $500 to $1,000. Delivering coal to the ship is a simple question, but the stowage of it in bunkers limits the speed of coaling.

The amount of cleaning usually required and the amount of harm done by the grit is no small item, not only when coaling, but when under ordinary steam, for soot and cinders are constantly being ejected from the funnel, while with oil fuel vessels could be kept much neater and much valuable time now devoted to holystoning decks, scrubbing gratings, and repainting upper works could be spent in more remunerative ways.

With liquid fuel the fires are perfectly steady, and the steam pressure may be kept constant, while the temperature of the stokehole is lower than with coal, owing to the fact that the furnace doors do not have to be opened and no hot cinders or ashes have to be pulled out. No smoke need be visible, which for certain purposes, such as fleet maneuvering, is a distinct advantage, while if it is desired to leave a trail of smoke for signaling purposes all that is required is to close the dampers or turn on more oil, and immediately dense, black smoke issues in clouds from the funnel.

As regards stowage, it is to be noticed that fuel oil will weigh approximately 50 to 60 pounds per cubic foot, the exact weight depending on the specific gravity of the particular oil and the temperature; consequently we may calculate 40 cubic feet to the ton, or about the same as coal, although there is a slight advantage to the oil; but the great advantage of fuel oil is in the facility with which it can be handled,

being a fluid, and that it contains more units of heat in a given weight than any other fuel which can be used economically.

Considerable attention has been given to the solidification of petroleum, but this is a step in the wrong direction, because the ease with which petroleum can be handled depends on its fluidity, and once solidified it would have but little advantage over the ordinary briquet fuel. Moreover, to solidify petroleum it must be mixed with sawdust, pulverized coal or some inert substance, or else a solid emulsion is made, in which alkalies are used. These do not add to the thermal qualities of the coal, and may even exert a deteriorating influence on the furnaces in which such fuel is used.

It may be taken as an axiom that the demand for space on all vessels, and especially on men-of-war, is never satisfied. This is another reason why the bunker space should be utilized and the ballast tanks made to carry the fuel.

We have previously mentioned some of the advantages of liquid fuel, but outside of fundamental advantages there are many practical advantages and conveniences, such as:

1. Diminished loss of heat up the funnel, owing to the clean condition the tubes can be kept in, and to the smaller amount of air which has to pass through the combustion chamber for a given fuel consumption.

2. A more equal distribution of heat in the combustion chamber, as the doors do not have to be opened and, consequently, a higher efficiency is obtained; and the heat is easier on the metal walls, for if one part is hotter than another uneven strains are set up.

3. With oil there is no chance of getting dirty fires on a hard run, as with coal.

4. A reduction in cost of handling fuel, since in one case it is all done mechanically or by gravitation, while with solid fuel a great deal of manual labor is required.

5. No firing tools or grate bars are used, consequently the furnace lining and brickwork floors, etc., suffer less damage.

6. No dust nor ashes to cover or fill the tubes and diminish the heating surface nor to be handled or carted away.

7. Petroleum does not suffer while being stored, while the deterioration of coal under atmospheric influence is well known, not to mention the expense and shrinkage in handling, labor of feeding fires, removing clinkers, etc.

8. Ease with which fire can be regulated from a low to a most intense heat in a short time.

9. Absence of sulphur or other impurities and longer life to plates, etc

10. Lessening of manual labor to fireman.

11. Great increase of steaming capacity, as was conclusively proved when many factories returned to coal in Pennsylvania and Ohio. They had to increase their boiler capacity about 35 per cent.

Even under conditions when coal is relatively cheaper than liquid fuel the advantages of the latter are sufficient to make its adoption desirable in order to make exceptionally large demands for steam.

The introduction of liquid fuel in a navy will always meet with great opposition from one of the following causes:

1. Reluctance to admit any improvement. 2. Opposition of coal-mine owners. 3. Probable increased expense. 4. Difficulty of obtaining liquid fuel.

The coal consumption of the world is probably in the neighborhood of 600,000,000 tons per annum, while that of petroleum is only about 17,000,000 tons, of which by far the greatest part is used for illuminating or lubricating purposes. So we see that the amount of petroleum available for fuel purposes is probably not more than 1 per cent of the coal used. Liquid fuel will therefore never be used very extensively as compared with coal, but when it is used it will have many advantages over the solid fuel. On vessels of war, and especially torpedo boats, it would give the very best results if used intelligently.

Russia and the United States are the only countries that could safely adopt liquid fuel for their naval vessels, owing to the fact that they are the only two countries that produce petroleum in sufficient quantity to warrant its adoption; but it is well to note that liquid fuel can be burned very advantageously in a furnace arranged for coal, and that change can be made from either fuel to the other in a few moments and without altering any of the arrangements. In such cases the grate bars are left in place and may be covered with coal or brick and the oil sprayed in above. The burners are fixed to swing on a joint, and in case of a necessity for using solid fuel are simply swung to one side out of the way.

Our present method of burning coal has improved but little, and it seems to the writer that there is a large field open for amelioration. Since liquid fuel can not be universally used, the next best thing would be to work out some practical plan for the burning of coal on the same lines as petroleum, by pulverizing and injecting it into the furnace in a finely divided condition, so that no large excess of air is required to consume it.

Those who have facilities for burning liquid fuel should keep this point before them, and, as probably the most practical method for burning pulverized coal will be on the same lines as burning liquid fuel, they would have good opportunities for comparative tests and the door might be opened for some radical improvement in burning coal.

PRODUCTION OF PETROLEUM IN COUNTRIES OF THE EASTERN CONTINENT.

RUSSIA.

Russia led the world in the production of petroleum during 1899, and surpassed her own high record of the year previous by nearly 6,000,000 barrels. For the second time in the history of the industry the yield of Russian oil exceeded that of the United States, which for many years had been the principal source of the world's supply of petroleum. More wells were drilled in Russia in 1899 than during any preceding year, and the number of producers has been largely increased. The average daily production was 13,000 barrels a day greater than in 1898, while that of 1898 showed a gain of over 20,000 barrels above the average daily yield of 1897.

The average production of the wells is steadily declining, and the gain in the gross production comes from the increasing number of new wells drilled from month to month. The average number of producing wells was 212 greater in 1899 than in 1898, while the increase in gross production per well was only 66 barrels per day, as against 142 barrels in 1898. Mr. James C. Chambers, United States consul at Baku, says:

The production of the wells finished in 1899 was also much less than the production of the wells finished in 1898, as, while in the latter year the initial production of 258 wells finished averaged 653 barrels per well per day, in 1899 the production of 370 wells completed averaged only 202 barrels per well per day. This decline was principally due to the fact that there were fewer large flowing wells in 1899 than in the previous year, and can not be considered to indicate a very serious falling off in the territory because those remarkably big flowing wells are possible at any time, and the result in 1900 may be quite as favorable as it seemed unfavorable in 1899.

Mr. Chambers believes that the limit of drilling operations in the Apsheron Peninsula has been reached, and unless some new territory is developed or some very large wells are struck the maximum of the Russian production has been reached. An increase in the new production for 1900 seems impossible of attainment.

The gross production of crude petroleum in the Baku district on the Apsheron Peninsula was 66,452,240 barrels in 1899, as compared with 60,597,544 barrels in 1898, and 54,744,303 barrels in 1897. The increase for the past year was 5,854,696 barrels, or 9.66 per cent. The increase of 1898 over 1897 was 5,853,241 barrels, or about 10.7 per cent, while the gross increase for 1897 was 5,111,051 barrels, or a gain of 10.3 per cent. If to this production at Baku is added the yield of the Grosni district, which was estimated at 2,300,000 barrels for 1899, and 2,200,000 barrels in 1898, it will bring Russia's total production of petroleum up to 68,752,240 barrels in 1899 and 62,797,544 barrels in 1898.

The increased demand for fuel oil has had a stimulating effect upon the Russian oil industry, but less attention has been given to the manufacture of an improved quality of illuminating oil. Foreign capitalists who have been investing large amounts of money in the Russian oil business in the past three years are looking more carefully after the residues, and the greater demand for petroleum fuel has resulted in bringing about better prices. It is stated on good authority that the demand for Russian oil for fuel purposes has increased 900 per cent in the past six years. The demand for fuel oil from the factories at Moscow has more than doubled in the same time, while the consumption on locomotives and river steamboats has likewise made enormous gains.

The principal object of the Russian refiner is to obtain the fuel oil, astatki or residuum, from the crude petroleum. Illuminating oil is merely a secondary consideration, and for some time has been regarded simply as a by-product. It is generally placed on the market at very low figures, and often below actual cost. During 1899 54.75 per cent of the total Russian production entered into the manufacture of residuum or fuel oil, while 26.43 per cent was used for illuminating, and only 2.6 per cent for lubricating, purposes. An advance in the price of refined oil during the last four months of 1899 changed these conditions to some extent, and on the whole the Russian oil industry for the past year was highly satisfactory and netted good returns to the investors.

WELLS COMPLETED IN THE RUSSIAN OIL FIELDS.

There were 370 wells completed in the Russian oil fields during 1899, as compared with 258 in 1898, a gain of 43 per cent. The average production of the new wells, however, declined from 653 barrels in

1898 to 202 barrels in 1899, a decrease of nearly 70 percent. The number of wells completed is very small in comparison with the number in the United States. Nearly 13,000 more wells were drilled in the United States in 1899 than in Russia. It will be noted, too, that the entire production of Russian oil, nearly 176,000 barrels a day, came from an average of 1,357 wells throughout the year. The total production of the United States in 1899 was 57,070,850 barrels, an average of about 156,000 barrels a day, while the number of producing wells in the United States is between 80,000 and 85,000. This would seem to give Russia an enormous advantage in the way of cheap production. One Russian well, on the average, produces as much oil as 60 American wells. The relative cost of drilling and operating wells in the two countries is very much in favor of the United States.

COST OF PRODUCTION.

Upon this point Mr. Chambers writes as follows:

There is no doubt whatever that the cost of producing oil at Baku increases steadily; the expense of drilling new wells adds much to this cost, but the greatest increase in the cost is due to the increased depth from which the oil must be raised and the steadily increasing amount of water in the wells. It has been explained in previous reports that the Baku wells are not pumped in the same manner as in the United States; that, owing to the great amount of sand always combined with the oil, the American system of pumping is impossible; that the Baku wells are worked with the bailer; but it has also been explained that the bailer used is made as large as possible. If the well is finished with 16-inch pipe, which is very commonly the case, the bailer will be as great in diameter as is possible to run inside that pipe and generally about 40 feet long, so that it will bring up not much less than a couple of barrels at a run. The line used for running the bailer is generally a wire cable, and has to be renewed in from six to nine months. With this explanation it will be understood that the deeper the well the fewer the runs of the bailer, and that with water in the wells the less oil the bailer will bring up, as the water must be kept down or it will eventually spoil the well. From excellent authority I learn that the water is confined to no particular part of the field, but is general, varying in quantity, however, in different wells. Some wells have so much water in them that it has been found unprofitable to work them; others having less water are worked by taking a bailer full of oil from the top, another full of oil and water mixed from the middle, and a third full of water from the bottom of the well, making three runs of the bailer for not much more than one bailer full of oil. There are other wells with still less water which can be worked by taking two or three bailers of oil to one of water.

While it is said that the water in the wells comes in from the shallower exhausted oil strata, it is undoubtedly salt water, very similar to the water of the Caspian Sea. The technical talent of the trade has been devoted for some years to finding some means of overcoming this very expensive difficulty, but, I understand, wholly without success. I am aware that this statement may surprise American producers, with their many successful methods of packing off the water; but it must not be overlooked that the soil at Baku differs materially from the generality of soil in the oil regions of the United States, being loose and sandy from the top to the bottom of the well, and consequently offering no solid basis for packing; even if an American packer could be inserted, the water would not be long in working around it.

Attempts have been made to shut the water off by pouring into the hole outside the pipe as much liquid cement as possible, which, when hardened, answered the purpose for a time; but the water eventually found its way around the cement.

There is still another condition which must eventually add materially to the cost of producing—that is, the steadily increasing royalties which must be paid for territory. Royalties at Baku are always so much per pood (36 pounds) on the oil produced, and not, as in the United States, a proportion of the oil itself. For years the average royalty paid was not more than half a kopeck per pood (about 2 cents per barrel of 42 gallons); but the higher prices realized for some years for crude have caused a very great advance in the royalty, as the Government has leased much land in the last two years at prices of from 2 to 11 kopecks per pood (8 to 46 cents per barrel), and always with the stipulation that a certain amount of royalty must be paid annually, whether oil is produced or not. Much of the drilling now being done is upon this Government land, and consequently as the new wells come in the royalty increases. In a few years this item will make a great addition to the cost of producing.

COST OF DRILLING.

Owing to the peculiar character of the formation in which the Russian oil is found, more precaution is necessary in drilling an oil well in that country than anywhere else. The expense of the iron pipe alone employed in casing amounts to from 25 to 40 per cent of the cost of the well. Starting with 26 or 28-inch riveted pipe or casing, it usually requires six different strings of casing, running down to 16 inches, one inside of the other, before the petroliferous strata can be reached by the drill. The wells are drilled with rods instead of a cable, being identically the same as the system employed in Canadian wells. There are always numerous accidents, owing to the bending of the rods, breaking of the drills, and the collapsing of the pipes or casing by the external pressure of the loose and caving strata. As a consequence it requires from eighteen months to two years to finish a well to a depth of 1,500 feet. On over 200 wells of an average depth of 924 feet eleven and one-half months was the average time consumed in drilling each well.

In one of these wells there were 84 feet of 26-inch pipe or casing, 252 feet of 24-inch pipe, 420 feet of 22-inch pipe, 588 feet of 20-inch pipe, 756 feet of 18-inch pipe, and 923.7 feet of 16-inch pipe. The entire weight of the iron pipe in this well was 4,808 poods, or nearly 87 tons. The cost of the pipe in this well alone was 11,540 rubles,[1] which is the equivalent of about $5,944. The cost of drilling such a well is 82.5 rubles for each 7 feet down to 700 feet. For every 70 feet following the contractor demands an additional 10 rubles for each 7 feet drilled. In the above well the drilling amounted to 11,566 rubles. The other expenses, such as riveting the pipes, furnishing steam power, lights, etc., brought the total up to 31,912 rubles.

THE RUSSIAN PIPE LINE.

The first section of the Russian pipe line from Baku to Batum was not entirely completed as promised at the close of 1899. The line was

[1] 1 ruble equals $0.515.

started about five years ago, and is to parallel the Trans-Caucasian Railway. The section from Batum to Michailov is 143 miles in length. The oil will have to be transported from Baku to Michailov by rail in tank cars, and from the latter point run through the pipe line to Batum. This is an 8-inch line constructed for refined oil, and will greatly increase the capacity of the railway. A large reservoir has been erected to receive the refined oil at Michailov. From this point to Batum there is a fall of 2,000 feet, and in case of a break in the line all the oil between the summit and the break would be lost. This necessitated placing self-closing valves about 630 feet apart, throughout the entire length of the line. It was the difficulty in procuring these valves that caused the delay in the operation of the line.

This pipe line was constructed by the engineers of the Trans-Caucasion Railway. The Russian Government granted the concession for it in March, 1890, but it was nearly five years later before an appropriation was made for it. The pipe is wrought iron, lap-welded, and was made in Russia from native materials. The first section has three pumping stations, located respectively at Michailov, Samtredi, and Soupson. Each station is provided with two pumping engines, one for continuous working and the second for reserve. There are six compound high-duty pumping engines with condensers and compensating cylinders, each engine having steam cylinders 21 and 42 inches in diameter, plungers of 8½ inches, all having a uniform stroke of 24 inches. Each engine works against a pressure in the delivery pipe of 650 pounds to the square inch, the steam pressure being 150 pounds to the square inch. Against this heavy pressure of 650 pounds per square inch, each engine will be required to deliver 416,275,200 gallons per year, this being the quantity of oil which will be pumped through this pipe. The contract for the supply and erection of these pumping engines was awarded by the board of the Imperial Russian State Railways to the representative of an American company.

RAILWAY TRANSPORTATION OF RUSSIAN OIL.

In regard to the transportation of Russian oil and its cost Mr. Chambers reports as follows:

The export of Russian oil continues to be limited by the transportation facilities from Baku to the Black Sea. There are now two routes of shipment to the Black Sea, the first and most important being the railway from Baku to Batum direct and the second by Caspian Sea to Petrovsk and thence by the Vladikavkas Railway to Novorossisk. The latter route is much longer and necessitates transshipment from vessels to tanks at Petrovsk and then from tanks into tank cars; consequently there must be greater loss than by direct shipment in cars to Batum. There is also a difference in the cost of transportation in favor of Batum, as the rail freight from Petrovsk to Novorossisk is 21.1 kopecks per pood (10.9 cents per 36 pounds), and the sea freight to Petrovsk from Baku about 1.5 kopecks (0.77 cent) per pood, making the total freight by that route about 22.6 kopecks per pood (11.6 cents per 36 pounds), against 16 kopecks (8.24 cents) per pood from Baku to Batum; but this difference is

considerably reduced by certain advantages given shippers by the Novorossisk route in excise allowance, so that the actual difference in favor of Batum is not more than 4.5 kopecks (2.3 cents) per pood.

Such a difference in the cost of transportation would seem to be sufficient to make the more expensive route impossible; but, as explained elsewhere, there is a great difference in the price of refined oil at Baku for shipment by the two routes. Refined oil on board tank cars at Baku for shipment to Batum is to-day worth about 49 kopecks (25.2 cents) per pood; and the supply is limited, owing to the number of cars that can be handled by the railway, while an unlimited amount of refined oil for sea shipment can be had at 32 kopecks (16.5 cents) per pood. The amount is unlimited because of the fact that the tonnage for bulk oil on the Caspian Sea is frequently idle because of the Volga being closed, but even in the season of Volga navigation the tonnage is greatly in excess of the requirements. This was demonstrated last year by the sea freight dropping to such a point that there was a loss in carrying to the vessel owners. The difference in the price of refined oil for the two routes of shipment, after deducting the 4.5 kopecks (2.3 cents) per pood difference in the cost of transportation, amounts to at least 12 kopecks per pood (6.18 cents per 36 pounds) in favor of the Petrovsk-Novorossisk route—quite sufficient to induce everybody in the export trade to endeavor to take advantage of that route, which, however, is exceedingly limited in capacity, resulting in delays in discharging vessels at Petrovsk and reduced deliveries at Novorossisk. The amount delivered at the latter place has averaged less than 10,000,000 gallons per month for several months. The railway can deliver about 25,000,000 gallons of illuminating oil per month at Batum; consequently, by the two routes, it is possible to get about 30,000,000 gallons per month to the Black Sea for export. As much of the Novorossisk deliveries is lubricating oil and refined for home trade, if the Baku production should be increased to double its present figure, the export can not be increased beyond the figures given until the transportation to the Black Sea is increased.

THE DEMAND FOR FUEL OIL.

The Russian oil industry of late years has derived its greatest profit from the increasing demand for it for fuel purposes. This demand has been so enormous that the refineries in many instances have been tempted to ship the crude article for this purpose almost in the state in which it comes from the wells. This makes it very dangerous, and steamers have refused to transport it to the interior parts of Russia unless it stands a certain test. Of course, increased production of the astatki or residuum means an increased output of refined. The results were that at the end of the year there was a heavy increase in the stocks of illuminating oil, with greatly reduced stocks of residuum as compared with the year preceding.

Consul-General Holloway says that in order to meet the increasing demand for liquid fuel Baku must increase her output from 242,000,000 poods to 360,000,000 poods (3,903,226 tons to 5,806,451 tons), and in order to supply the increasing demand from the interior of Russia it will be necessary to increase the output of residues to 8,064,516 tons in the near future. This development will require a further investment of $88,000,000, which must come from foreigners. Increased production of illuminating oil is necessary to supply the fuel residues,

and unless the export of Russian oil is increased, the liquid fuel will contain so great a percentage of volatile products as to be highly dangerous for profitable trade.

This mazoot, astatki, or residuum is an ideal fuel and its importance is being more fully realized each year. It is destined to supply the place of the inferior coal offered in this section of Europe, and must find an increasing demand for seagoing vessels, railroads, and metallurgical purposes. The ease with which it is manipulated, saving in bulk and weight, as well as safety under proper regulation, are all in its favor. A number of practical tests have proved that 1 pound of this liquid fuel when used under boilers will accomplish as much as 2 pounds of average coal.

PRICE OF PETROLEUM PRODUCTS AT BAKU.

The report of Consul Chamberlain contains the following information in regard to the price of Russian petroleum:

The fluctuations in the price of crude at wells were confined to between 11 and 13 kopecks per pood (70 to 80 cents per barrel of 42 gallons) the first half of the year, but advanced gradually till it reached 17 kopecks per pood (about $1.05 per barrel) in November, and has remained practically at that figure up to the present. Residuum was about 13 kopecks per pood (80 cents per barrel) at the opening of the year, and remained at about that figure till July, when it commenced to advance and reached 15 kopecks (7.7 cents) in December, at which it may be quoted now. It will be seen that the highest prices for both crude and residuum were not reached until after the close of the season of Volga navigation, when, by reason of the impossibility of shipping by the Volga, the demand is greatly reduced, and residuum at least must be carried for several months till the shipping season opens. This would seem to indicate still higher prices when this season comes.

Refined oil free on board cars for Batum, which was quoted at about 22 kopecks per pood (2.3 cents per gallon) at the opening of the year, declined to about 15½ kopecks (about 1.6 cents per gallon) in March and remained at about that figure till the end of May, when it started to advance, and by fractional moves reached about 25 kopecks per pood (2.6 cents per gallon) in August, when the advance was accelerated by the advance in the United States, no doubt. The price reached 56 to 57 kopecks per pood (6 cents per gallon) in December, with sales reported for January shipment at a still higher figure. These high prices were, however, only for such refined as cars could be furnished for, as refined for shipment via the Caspian Sea to Petrovsk and from there by rail to Novorossisk, on the Black Sea, did not go above 32 kopecks per pood (3.3 cents per gallon); consequently the difference was practically a premium upon transportation capacity and was due to both an increased demand at Batum and decreased rail transportation, owing to lack of facilities of the railway. Notice was given in November that the railway freight on refined for export from Baku to Batum would be increased from 12 to 16 kopecks per pood (6.18 to 8.24 cents per 36 pounds) on January 27, and notwithstanding the fact that the prices in the markets abroad justify a much higher price, and that it must be well known that the Batum exporters do not receive sufficient refined to meet the demands, the price has declined since the advance in freight took place till at present it can not be quoted above 50 kopecks (25.8 cents) per pood free on board cars at Baku, while refined for Caspian shipment remains strong at 32 kopecks (11.3 cents).

The following table shows that only 21.1 per cent of the Russian production was converted into illuminating and lubricating oils. Their sum was 14,000,000 barrels. The amount of illuminating and lubricating oil, together with the lighter products produced in the United States in 1899, must amount to 46,500,000 barrels; over three times the quantity produced in Russia.

PRODUCTION.

The total production of crude petroleum in the Apsheron Peninsula and the shipments of the chief petroleum products from Baku from 1880 to 1899 have been as follows:

Total production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku from 1880 to 1899.

[Barrels.]

Year.	Production.	Shipments from Baku.					
		Illuminating.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
1880	3,055,247	976,933	....	....	867,416	....	1,844,349
1881	4,889,640	1,564,337	....	....	1,136,228	....	2,700,565
1882	6,111,740	1,650,207	37,335	....	2,200,276	....	3,887,818
1883	7,333,838	1,833,149	139,384	....	2,297,347	....	4,269,880
1884	11,002,624	2,689,365	182,941	....	3,569,226	....	6,441,532
1885	14,179,833	3,666,297	195,386	....	4,144,185	....	8,005,868
1886	18,336,463	4,278,591	207,831	....	4,424,198	....	8,910,620
1887	20,170,856	5,378,729	281,257	....	5,072,582	....	10,732,568
1888	23,471,270	6,111,739	317,348	....	7,150,897	....	13,579,984
1889	25,060,496	7,469,438	415,648	....	10,831,296	550,122	19,266,504
1890	29,217,126	8,227,384	562,347	....	11,858,191	855,745	21,503,667
1891	35,206,905	9,046,454	623,472	....	12,640,386	1,454,969	23,765,281
1892	36,430,248	9,608,801	696,821	....	14,254,280	1,466,993	26,026,895
1893	41,198,085	10,501,222	709,046	....	17,542,787	1,577,018	30,330,073
1894	37,811,773	8,704,156	782,396	....	23,667,482	2,102,690	35,256,724
1895	47,713,983	9,898,288	825,489	130,465	22,050,232	1,849,780	34,754,254
1896	49,633,252	10,569,670	1,084,095	123,753	22,616,271	3,117,898	37,511,687
1897	54,744,303	11,042,054	1,114,180	144,988	27,106,357	2,896,333	42,303,912
1898	60,597,544	11,569,804	1,273,961	177,262	29,628,484	5,365,770	48,015,281
1899	66,452,240	12,612,469	1,398,044	150,367	29,933,496	2,986,186	47,080,562

The above table gives the production and shipments of refined products and residuum from Baku. A part of the refined products and the residuum goes to inland ports by way of the Caspian Sea and the Volga River. The larger portion is shipped by rail to Batum, on the Black Sea, and from there distributed.

Two distinct statements in regard to the production of Russian crude petroleum are given. One is known as "total production," which includes not only the crude, collected and refined, or sold as fuel oil, but also an estimate of the oil wasted or not collected, as well

also as that used for fuel for pumping the wells. The second statement shows "profitable production;" that is, the amount of crude oil put into tanks or reservoirs.

The "profitable production" for the last twelve years is shown in the following table:

"Profitable production" of crude petroleum in the Apsheron Peninsula from 1888 to 1899.

[Barrels of 42 gallons.]

Year.	Production.	Year.	Production.
1888	22, 249, 389	1894	36, 375, 428
1889	23, 502, 163	1895	46, 140, 174
1890	27, 660, 953	1896	47, 220, 633
1891	33, 565, 819	1897	51, 645, 568
1892	35, 026, 144	1898	59, 409, 357
1893	39, 703, 304	1899	64, 205, 063

The divisions of this "profitable production" among the four subfields on the Apsheron Peninsula are as follows:

"Profitable production" of the several fields of the Apsheron Peninsula from 1889 to 1899.

[Barrels.]

Year.	Balakhany.	Saboontchy.	Romany.	Bibi-Eibat.	Total.
1889	8, 424, 364	12, 905, 012	....	2, 172, 787	23, 502, 163
1890	7, 742, 995	17, 525, 134	189, 022	2, 203, 802	27, 660, 953
1891	9, 067, 861	19, 992, 359	1, 585, 342	2, 920, 257	33, 565, 819
1892	7, 025, 973	18, 916, 516	5, 017, 286	4, 066, 369	35, 026, 144
1893	7, 070, 101	17, 883, 692	8, 943, 313	5, 806, 198	39, 703, 304
1894	7, 217, 054	17, 485, 232	7, 542, 922	4, 130, 220	36, 375, 428
1895	8, 258, 961	18, 500, 196	13, 619, 639	5, 761, 378	46, 140, 174
1896	10, 470, 315	18, 664, 322	9, 546, 250	8, 539, 746	47, 220, 633
1897	11, 774, 479	20, 406, 918	11, 821, 815	7, 642, 356	51, 645, 568
1898	12, 921, 001	22, 396, 000	12, 292, 016	11, 800, 340	59, 409, 357
1899	14, 040, 850	28, 209, 938	12, 051, 563	*a* 9, 902, 712	64, 205, 063

a Includes 19,973 barrels produced in Binagadi, a new subfield.

WELLS AND THEIR PRODUCTION.

There are two classes of wells producing oil—flowing and bucketing. By bucketing it is understood that, owing to the loose sand that continually comes into the well with the oil, the American system of pumping—with rods, cups, and working barrel—is impracticable, as the

sharp sand soon cuts the cups. The substitute is a long pipe or bailer that goes inside of the casing, with a valve in the bottom, and connected to a small wire rope passing over the crown pulley. This rope is also connected with a drum driven by power. The bailer is hoisted to the surface, where the valve is opened automatically and the oil and water are discharged in a trough leading to a reservoir. The bailer is then relowered and refilled.

The production of crude petroleum from pumping (bucketing) and flowing wells for the last twelve years has been as follows:

Production of crude oil from pumping and flowing wells in Baku from 1888 to 1899.

[Barrels.]

Year.	Pumping.	Flowing.
1888	13, 325, 184	8, 924, 205
1889	18, 300, 733	5, 201, 430
1890	21, 589, 242	6, 071, 711
1891	28, 777, 506	4, 788, 313
1892	25, 765, 482	9, 260, 662
1893	26, 352, 714	13, 350, 590
1894	28, 814, 428	7, 561, 000
1895	32, 350, 809	13, 789, 365
1896	36, 586, 526	10, 634, 107
1897	40, 784, 321	10, 861, 247
1898	45, 577, 083	13, 832, 274
1899	54, 365, 454	9, 839, 609

The profitable production from pumping and flowing wells for years 1892 to 1899 is given in the following table, by fields:

Production of crude petroleum from pumping wells, 1892 to 1899.

[Barrels of 42 gallons.]

Year.	Balakhany.	Saboontchy.	Romany.	Bibi-Eibat.	Total.
1892	7, 025, 973	14, 234, 073	2, 558, 238	1, 947, 198	25, 765, 482
1893	7, 041, 496	14, 465, 119	3, 560, 680	1, 285, 419	26, 352, 714
1894	7, 217, 054	16, 245, 868	4, 221, 278	1, 130, 228	28, 814, 428
1895	8, 258, 961	16, 227, 824	5, 254, 480	2, 609, 544	32, 350, 809
1896	10, 452, 222	16, 938, 528	7, 021, 311	2, 174, 465	36, 586, 526
1897	11, 773, 063	18, 521, 553	8, 105, 441	2, 384, 264	40, 784, 321
1898	12, 742, 529	19, 908, 639	8, 450, 123	4, 475, 792	45, 577, 083
1899	14, 039, 627	23, 841, 356	9, 158, 898	7, 325, 573	54, 365, 454

Production of crude petroleum from flowing wells, 1892 to 1899.

[Barrels of 42 gallons.]

Year.	Balakhany.	Sabooutchy.	Romany.	Bibi-Eibat.	Total.
1892	....	4, 682, 443	2, 459, 048	2, 119, 171	9, 260, 662
1893	28, 605	3, 418, 573	5, 382, 633	4, 520, 779	13, 350, 590
1894	....	1, 239, 364	3, 321, 644	2, 999, 992	7, 561, 000
1895	....	2, 272, 372	8, 365, 159	3, 151, 834	13, 789, 365
1896	18, 093	1, 725, 794	2, 524, 939	6, 365, 281	10, 634, 107
1897	....	1, 883, 602	3, 718, 302	5, 259, 343	10, 861, 247
1898	171, 200	2, 494, 916	3, 840, 319	7, 325, 839	13, 832, 274
1899	1, 223	4, 368, 582	2, 892, 665	2, 577, 139	9, 839, 609

The greatest number of wells that produced crude petroleum at any time during the years named was as follows:

Greatest number of producing wells at any time on the Apsheron Peninsula from 1888 to 1899.

Year.	Wells.	Year.	Wells.
1888	239	1894	532
1889	278	1895	604
1890	356	1896	736
1891	458	1897	917
1892	448	1898	1, 107
1893	458	1899	1, 357

The statement of the number of producing wells from 1890 to 1899, by months, is as follows:

Average number of producing wells in Baku from 1890 to 1899, by months.

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	218	271	312	322	322	434	501	599	732	915
February	214	275	312	326	337	434	508	598	747	923
March	226	261	317	332	347	437	511	614	768	942
April	227	289	306	323	355	455	536	626	755	958
May	229	299	302	325	366	451	540	643	764	986
June	235	305	269	310	369	450	547	658	791	991
July	244	309	223	307	373	460	566	668	809	1, 015
August	250	312	267	294	400	475	575	677	806	1, 038
September	245	326	291	298	413	496	597	688	828	1, 067
October	260	332	325	310	420	497	606	713	863	1, 084
November	262	324	323	316	425	504	614	697	869	1, 118
December	262	318	324	322	440	500	620	702	905	1, 128
Greatest number.	356	458	448	458	532	604	736	917	1, 107	1, 357

The above table gives the average number of wells in operation during each month. The footing represents the greatest number of wells opened during the year in Baku.

The number of wells drilling and the number completed during each month from 1890 to 1899 are given in the following tables:

Average number of wells drilling in Baku from 1890 to 1899, by months.

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	74	145	141	62	59	80	137	207	281	432
February	79	150	131	57	60	86	141	225	278	460
March	82	154	127	69	62	86	145	208	295	498
April	86	149	117	64	72	78	150	221	306	529
May	91	150	94	69	81	86	152	216	306	562
June	91	142	84	73	79	89	159	225	323	563
July	91	141	44	69	75	100	152	235	334	553
August	91	145	45	64	73	109	152	259	339	547
September	116	140	52	58	73	116	164	272	360	565
October	124	136	45	59	69	122	194	279	361	569
November	129	129	50	58	71	133	200	287	390	579
December	138	122	58	59	75	139	208	291	437	583
Greatest number.	231	291	200	175	204	269	384	545	706	1,001

The year 1899, as shown in the above table, indicates great activity in the field work at Baku.

Number of wells completed in Baku from 1890 to 1899.

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	1	7	14	16	6	5	13	10	30	20
February	4	12	7	2	8	8	11	7	16	21
March	6	15	10	6	2	7	7	11	18	19
April	6	18	6	2	6	10	8	18	29	15
May	9	15	9	5	8	6	6	24	6	24
June	7	10	5	7	7	5	13	25	18	41
July	7	10	5	5	10	9	13	19	24	36
August	5	10	7	3	8	11	10	21	19	37
September	5	12	6	6	10	8	16	12	26	36
October	8	17	8	7	9	8	16	22	24	35
November	16	10	5	5	8	6	10	17	25	29
December	11	14	1	4	8	11	11	17	23	32
Year	85	150	83	68	90	94	134	203	258	345

Number of wells started drilling in Baku from 1890 to 1899.

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	7	15	13	8	3	10	13	24	28	52
February	8	20	7	11	7	9	7	8	30	61
March	10	11	2	5	12	5	16	21	34	54
April	9	11	6	4	16	11	16	18	24	52
May	9	19	6	8	3	8	10	30	29	43
June	7	14	1	3	5	16	16	34	36	38
July	18	6	.....	1	6	19	12	29	36	45
August	18	11	1	5	5	19	12	38	35	55
September	20	9	8	3	6	14	27	30	34	51
October	15	7	3	2	8	12	36	26	54	36
November	22	9	3	6	15	18	20	21	75	51
December	14	15	9	4	16	17	24	21	41	44
Year	157	147	59	60	102	158	209	300	456	582

Number of wells drilled deeper in Baku from 1890 to 1899.

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	7	20	35	37	27	23	47	45	47	48
February	6	25	43	37	31	33	31	45	53	51
March	8	20	51	41	38	23	43	37	52	57
April	10	19	50	44	47	25	42	37	55	41
May	8	21	39	41	42	35	45	30	65	51
June	14	23	32	42	37	32	44	32	67	53
July	13	21	13	37	33	37	45	38	61	60
August	16	27	18	40	28	35	42	46	63	58
September	14	23	19	32	29	35	52	45	70	65
October	15	34	23	38	25	36	56	51	65	67
November	16	31	28	30	24	32	43	50	61	55
December	14	31	30	22	20	33	44	44	56	60
Year	50	87	111	102	101	133	173	155	216	197

In the table following is given a statement of the greatest number of wells drilling at any time during each of the years from 1889 to 1899, together with the total number of wells drilled deeper, and the total length, in sagenes, of all wells drilled.

Total number of wells started drilling, greatest number of wells drilling, number of wells completed, greatest number of wells drilled deeper, greatest number of wells producing, and total length, in sagenes, of wells drilled in Baku from 1889 to 1899.

[1 sagene = 7 feet.]

Year.	Number of wells started drilling.	Total number of wells drilling.	Number of wells completed.	Total number of wells drilled deeper.	Number of producing wells.	Total length of wells drilled.
						Sagenes.
1889	....	121	....	28	....	6,500
1890	157	231	85	50	356	14,810
1891	147	291	150	87	458	19,980
1892	59	200	83	111	448	11,670
1893	60	175	68	102	458	10,984
1894	102	204	90	101	532	12,859
1895	158	269	94	133	604	20,762
1896	209	384	134	173	736	28,124
1897	300	545	203	155	917	39,841
1898	456	706	258	216	1,107	57,511
1899	582	1,001	345	197	1,357	81,797

The following table shows the average daily production of crude petroleum in the Baku field in 1898 and 1899, taken from the consular report of Mr. James C. Chambers:

Average daily production of the Baku fields in 1898 and 1899.

[Barrels of 42 gallons.]

Month.	Flowing wells.		Pumping wells.	
	1898.	1899.	1898.	1899.
January	59,365	38,744	113,156	130,075
February	103,963	53,636	113,729	131,808
March	23,861	40,072	118,589	140,973
April	33,492	34,432	117,576	138,745
May	24,129	46,653	123,670	135,984
June	16,020	24,284	126,297	142,590
July	30,015	20,109	122,197	148,230
August	22,933	15,344	119,624	149,839
September	29,764	10,092	125,737	157,931
October	40,212	14,760	130,063	158,351
November	27,960	14,948	129,378	157,043
December	37,797	6,193	128,398	158,129
Year	37,202	26,445	122,413	146,216

Average daily production of the Baku fields in 1898 and 1899—Continued.

[Barrels of 42 gallons.]

Month.	Total.		Stocks at wells at end of month.	
	1898.	1899.	1898.	1899.
January	172, 521	168, 817	1, 491, 835	809, 740
February	217, 692	185, 444	2, 806, 376	1, 018, 898
March	142, 450	181, 085	1, 929, 990	759, 351
April	151, 068	173, 177	1, 612, 813	769, 334
May	147, 799	182, 607	1, 137, 625	802, 190
June	142, 317	166, 874	665, 803	747, 870
July	152, 212	168, 339	488, 786	893, 651
August	142, 557	165, 183	509, 309	689, 413
September	155, 501	168, 023	558, 774	643, 592
October	170, 275	173, 111	644, 544	640, 399
November	157, 338	171, 991	639, 528	684, 827
December	168, 195	164, 322	859, 584	858, 238
Year	159, 615	172, 661	....	....

WELL RECORDS AT BAKU.

As reported by Mr. Chambers, the following tables give the number of wells completed, average depth, and average daily product in 1898 and 1899, by fields and months:

Number of wells completed in Baku in 1898 and 1899, with average depth and average daily product, by fields and months.

Month.	Balakhani-Sabountchy.			Romany.		
	Wells.	Average depth.	Average production.	Wells.	Average depth.	Average production.
1898.		*Feet.*	*Barrels.*		*Feet.*	*Barrels.*
January	22	725	270	6	1, 453	160
February	14	752	207	1	1, 540	3, 600
March	16	918	602	1	1, 638	73
April	24	837	248	2	1, 153	281
May	5	890	623	1	1, 292	5, 041
June	15	891	319	1	1, 652	254
July	20	873	568	2	1, 425	260
August	18	933	203	1	1, 624	2, 447
September	24	801	255	1	1, 295	4, 000
October	21	917	226	2	1, 306	464
November	23	902	436	1	1, 540	213
December	20	880	259	2	1, 673	163
Year	222	845	331	21	1, 448	912

Number of wells completed in Baku in 1898 and 1899, with average depth and average daily product, by fields and months—Continued.

Month.	Balakhani-Sabooutchy.			Romany.		
	Wells.	Average depth.	Average production.	Wells.	Average depth.	Average production.
1899.		*Feet.*	*Barrels.*		*Feet.*	*Barrels.*
January	29	798	343	1	1,267	213
February	26	973	132	2	1,340	433
March	17	939	252	1	1,596	255
April	12	980	192	2	1,421	240
May	25	808	108	5	1,225	230
June	35	889	194	7	1,379	33
July	33	784	132	4	1,463	106
August	35	746	142	2	861	516
September	24	889	106	3	1,631	190
October	36	938	159	2	1,008	406
November	26	812	163	2	1,554	135
December	33	896	156	1	777	123
Year	331	862	170	32	1,329	201

Month.	Bibi-Eibat.			Total.		
	Wells.	Average depth.	Average production.	Wells.	Average depth.	Average production.
1898.		*Feet.*	*Barrels.*		*Feet.*	*Barrels.*
January	2	1,596	29,094	30	932	2,522
February	1	1,682	2,682	16	861	460
March	1	1,495	2,858	18	988	781
April	3	1,484	1,001	29	925	329
May	....	....	....	6	958	902
June	2	1,673	339	18	960	304
July	2	1,517	979	24	972	579
August	....	....	....	19	970	321
September	1	1,750	240	26	857	420
October	1	1,827	100	24	987	248
November	1	1,554	6,880	25	954	538
December	1	1,694	273	23	985	249
Year	15	1,595	5,075	258	937	653

Number of wells completed in Baku in 1898 and 1899, with average depth and average daily product, by fields and months—Continued.

Month.	Bibi-Eibat.			Total.		
	Wells.	Average depth.	Average production.	Wells.	Average depth.	Average production.
1899.		*Feet.*	*Barrels.*		*Feet.*	*Barrels.*
January				30	813	339
February	1	1,254	534	29	1,008	187
March	1	1,043	4,879	19	980	496
April	1	742	1,059	15	1,030	251
May				30	875	138
June	1	1,995	392	43	994	173
July	1	861	347	38	861	134
August				37	753	167
September	1	1,368	4,551	28	987	274
October				38	945	172
November	1	1,890	146	29	901	160
December				34	889	155
Year	7	1,308	1,701	370	911	202

From the above table it would appear that the average depth of the wells was decreasing, the figures showing 911 feet in 1899 as compared with 937 feet in 1898. The drilling, however, is not getting shallower, as shown by the number of wells that are being drilled deeper all the time. The decrease in depth shown above is due to the fact that more wells were drilled in the shallower older territory of Balakhani and Saboontchy, which wells are also smaller than wells in the newer territory where the oil sand is deeper.

Mr. Chambers gives the following as the number of wells producing, flowing, and drilling in Baku in 1898 and 1899, by fields and months:

Number of wells producing, flowing, and drilling in Baku in 1898 and 1899.

Month.	Balakhani-Saboontchy.		Romany.		Bibi-Eibat.		Total.	
	1898.	1899.	1898.	1899.	1898.	1899.	1898.	1899.
Wells producing.								
January	619	776	82	96	31	42	732	914
February	639	786	82	96	26	41	747	923
March	659	799	76	97	33	46	768	942
April	644	807	79	106	32	45	755	958
May	642	825	84	112	38	46	764	986
June	670	832	81	114	40	45	791	991
July	683	856	86	113	40	46	809	1,015
August	690	876	83	114	33	48	806	1,038
September	706	905	84	115	38	47	828	1,067
October	736	915	86	118	41	51	865	1,084
November	740	958	90	121	39	56	869	1,135
December	770	951	93	122	42	55	905	1,128
Average for the year	......	......	......	......	......	......	803	1,015
Flowing wells.								
January	2	8	4	3	3	2	9	13
February	1	4	6	1	4	3	11	8
March	3	4	4	5	4	2	11	11
April	4	2	3	5	3	2	10	9
May	1	1	5	4	4	2	10	7
June	4	2	5	3	5	2	14	7
July	5	1	5	2	5	3	15	6
August	6	......	5	2	4	1	15	3
September	6	......	6	1	3	2	15	3
October	5	1	5	......	3	1	13	2
November	3	3	7	2	4	1	14	6
December	9	......	4	1	1	1	14	2
Average for the year	......	......	......	......	......	......	13	6

Number of wells producing, flowing, and drilling in Baku in 1898 and 1899—Continued.

Month.	Balakhani-Saboontchy.		Romany.		Bibi-Eibat.		Total.	
	1898.	1899.	1898.	1899.	1898.	1899.	1898.	1899.
Wells started drilling.								
January	23	49	5	3	......	1	28	53
February	27	55	3	5	......	1	30	61
March	30	46	2	7	2	1	34	54
April	21	52	3	4	......	1	24	57
May	25	34	3	7	1	2	29	43
June	34	32	2	6	......	......	36	38
July	35	28	1	8	......	9	36	45
August	30	33	5	5	......	17	35	55
September	32	43	2	3	......	5	34	51
October	48	19	3	13	3	14	54	46
November	71	41	2	4	2	6	75	51
December	34	34	7	9	......	1	41	44
Total	410	466	38	74	8	58	456	598

The following table shows the gross production of flowing wells in 1898 and 1899:

Gross production (flowing wells) of Baku fields in 1898 and 1899.

[Barrels of 42 gallons.]

Month.	Balakhani-Saboontchy.		Romany.	
	1898.	1899.	1898.	1899.
January	46,200	785,760	181,320	174,480
February	12,000	1,236,480	585,240	68,280
March	139,200	683,760	309,600	283,680
April	298,440	208,560	180,600	483,120
May	48,000	676,080	257,280	645,000
June	158,400	157,440	207,240	410,520
July	166,560	7,800	226,920	350,400
August	141,600	....	347,640	241,320
September	164,760	....	396,720	97,680
October	478,960	291,840	417,960	....
November	289,200	241,680	261,600	74,280
December	674,520	....	400,920	4,800
Total	2,617,840	4,289,400	3,773,040	2,833,560

Gross production (flowing wells) of Baku fields in 1898 and 1899—Continued.

[Barrels of 42 gallons.]

Month.	Bibi-Eibat.		Total.	
	1898.	1899.	1898.	1899.
January	1,612,800	240,840	1,840,320	1,201,080
February	2,313,720	197,040	2,910,960	1,501,800
March	290,880	274,800	739,680	1,242,240
April	525,720	341,280	1,004,760	1,032,960
May	443,520	125,160	748,800	1,446,240
June	114,960	160,560	480,600	728,520
July	537,000	265,200	930,480	623,400
August	220,800	234,360	710,040	475,680
September	331,440	205,080	892,920	302,760
October	350,640	165,720	1,247,560	457,560
November	288,000	132,480	838,800	448,440
December	158,280	187,200	1,233,720	192,000
Total	7,187,760	2,529,720	13,578,640	9,652,680

SHIPMENTS FROM BAKU.

The following table contains the shipments from Baku by railroad and by sea during 1898 and 1899, by months, as taken from the report of Mr. James C. Chambers:

Output of all petroleum products from Baku in the years 1898 and 1899.

[Gallons.]

Month.	Illuminating oil.		Lubricating oil.		Residuum.	
	1898.	1899.	1898.	1899.	1898.	1899.
By railway.						
January	21,800,000	25,780,000	2,495,000	4,195,000	1,260,000	1,310,000
February	25,080,000	25,855,000	2,230,000	3,040,000	1,400,000	1,510,000
March	26,835,000	29,710,000	4,175,000	3,755,000	2,305,000	3,020,000
April	26,655,000	25,360,000	2,050,000	3,455,000	4,050,000	2,205,000
May	27,965,000	24,215,000	5,450,000	3,445,000	1,050,000	1,620,000
June.............	24,165,000	26,685,000	4,800,000	3,625,000	1,600,000	2,975,000
July	23,780,000	25,505,000	2,195,000	3,245,000	1,960,000	1,575,000
August	24,550,000	26,755,000	3,180,000	3,385,000	2,035,000	1,605,000
September.......	19,595,000	27,800,000	3,085,000	4,035,000	2,200,000	1,840,000
October..........	25,745,000	26,510,000	3,295,000	3,295,000	4,850,000	805,000
November.......	29,600,000	18,950,000	2,945,000	2,705,000	2,390,000	1,225,000
December	26,350,000	17,320,000	3,015,000	3,835,000	1,535,000	1,615,000
Total	302,120,000	300,415,000	38,915,000	42,015,000	26,635,000	21,305,000
By sea.						
January	4,025,000	1,465,000	625,000	30,000	4,375,000	6,735,000
February	3,015,000	3,065,000	335,000	390,000	8,420,000	6,830,000
March	8,400,000	17,040,000	1,280,000	1,165,000	43,860,000	133,105,000
April	19,595,000	20,680,000	1,505,000	1,700,000	131,000,000	157,810,000
May	16,925,000	22,625,000	830,000	2,535,000	173,370,000	174,085,000
June.............	20,500,000	24,275,000	705,000	1,340,000	160,850,000	163,885,000
July	27,215,000	26,145,000	2,430,000	2,215,000	219,065,000	167,400,000
August	23,190,000	28,980,000	2,620,000	2,375,000	190,065,000	149,415,000
September.......	23,630,000	27,240,000	1,680,000	1,610,000	164,155,000	135,445,000
October..........	15,330,000	20,985,000	960,000	1,235,000	78,615,000	89,490,000
November.......	4,395,000	10,430,000	195,000	365,000	4,775,000	9,580,000
December	4,865,000	9,460,000	25,000	40,000	6,620,000	9,220,000
Total	171,085,000	215,390,000	13,190,000	15,000,000	1,185,170,000	1,203,000,000
Total shipments.						
January	25,825,000	30,245,000	3,120,000	4,225,000	5,635,000	8,045,000
February	28,095,000	28,920,000	2,565,000	3,430,000	9,820,000	8,340,000
March	35,235,000	46,750,000	5,455,000	4,920,000	46,165,000	136,125,000
April	46,250,000	46,040,000	3,555,000	5,155,000	135,050,000	160,015,000
May	44,890,000	46,840,000	6,280,000	5,980,000	174,420,000	175,705,000
June.............	44,665,000	50,960,000	5,505,000	4,965,000	162,450,000	166,860,000
July	50,995,000	51,650,000	4,625,000	5,460,000	221,025,000	168,975,000
August	47,740,000	55,735,000	5,800,000	5,760,000	192,100,000	151,020,000
September.......	43,225,000	55,040,000	4,765,000	5,645,000	166,355,000	137,285,000
October..........	41,075,000	47,495,000	4,255,000	4,530,000	83,465,000	90,295,000
November.......	33,995,000	29,380,000	3,140,000	3,070,000	7,165,000	10,805,000
December	31,215,000	26,780,000	3,040,000	3,875,000	8,155,000	10,835,000
Grand total.	473,205,000	515,835,000	52,105,000	57,015,000	1,211,805,000	1,224,305,000

Output of all petroleum products from Baku in the years 1898 and 1899—Continued.

[Gallons.]

Month.	Crude.		Total.	
	1898.	1899.	1898.	1899.
By railway.				
January	2,635,000	4,630,000	28,190,000	35,915,000
February	5,420,000	4,280,000	34,130,000	34,685,000
March	4,750,000	5,260,000	38,065,000	41,745,000
April	2,095,000	4,675,000	34,850,000	35,695,000
May	7,890,000	4,390,000	42,355,000	33,670,000
June	8,200,000	4,395,000	38,765,000	37,680,000
July	1,005,000	4,720,000	28,940,000	35,045,000
August	680,000	4,905,000	30,445,000	36,650,000
September	3,695,000	4,205,000	28,575,000	37,880,000
October	2,830,000	4,655,000	36,720,000	35,265,000
November	4,240,000	3,860,000	39,175,000	26,740,000
December	5,570,000	2,720,000	36,470,000	25,490,000
Total	49,010,000	52,695,000	416,680,000	416,460,000
By sea.				
January	2,175,000	205,000	11,200,000	11,435,000
February	2,130,000	545,000	13,900,000	10,830,000
March	16,605,000	4,570,000	70,145,000	155,880,000
April	18,550,000	10,730,000	170,650,000	190,920,000
May	41,675,000	11,905,000	232,800,000	211,150,000
June	39,900,000	10,030,000	221,955,000	199,530,000
July	6,005,000	9,960,000	254,715,000	205,720,000
August	19,875,000	10,370,000	235,750,000	191,140,000
September	16,190,000	6,440,000	205,655,000	170,735,000
October	7,050,000	2,070,000	101,955,000	113,780,000
November	120,000	1,365,000	9,485,000	21,740,000
December	175,000	545,000	11,685,000	19,265,000
Total	170,450,000	68,735,000	1,539,895,000	1,502,125,000
Total shipments.				
January	4,810,000	4,835,000	39,390,000	47,350,000
February	7,550,000	4,825,000	48,030,000	45,515,000
March	21,355,000	9,830,000	108,210,000	177,625,000
April	20,645,000	15,405,000	205,500,000	226,615,000
May	49,565,000	16,295,000	275,155,000	244,820,000
June	48,100,000	14,425,000	260,720,000	237,210,000
July	7,010,000	14,680,000	283,655,000	240,765,000
August	20,555,000	15,275,000	266,195,000	227,790,000
September	19,885,000	10,645,000	234,230,000	208,615,000
October	9,880,000	6,725,000	138,675,000	149,045,000
November	4,360,000	5,225,000	48,660,000	48,480,000
December	5,745,000	3,265,000	48,155,000	44,755,000
Grand total.	219,460,000	121,430,000	1,956,575,000	1,918,585,000

SHIPMENTS FROM BATUM.

The following table contains the shipments of the products of petroleum to different countries in 1898 and 1899 as reported by Mr. James C. Chambers:

Shipments of petroleum products from Batum in the years 1898 and 1899.

[Gallons.]

To—	Crude and residuum.		Lubricating.		Illuminating distillate.	
	1899.	1898.	1899.	1898.	1899.	1898.
Austria-Hungary	426, 320	176, 850	3, 598, 125	2, 985, 615	8, 974, 820	11, 176, 665
Belgium	4, 127, 920	3, 723, 720	8, 033, 870	8, 047, 315	449, 580	159, 490
Bulgaria	4, 850	27, 450	70, 050	46, 150		
Cochin-China						
China						
Egypt	56, 100	20, 450	167, 650	114, 550		
France	1, 814, 095	2, 373, 630	8, 514, 075	9, 338, 175	15, 074, 440	14, 864, 665
Germany	991, 440	2, 020, 955	10, 579, 140	10, 601, 800	97, 495	78, 305
India		89, 050		100, 000		
Italy	1, 948, 040	1, 056, 340	350, 900	316, 750		
Japan						
Java						
Malta						
Netherlands			103, 500	5, 000		
Philippines						
Roumania	1, 300	1, 000	87, 550	142, 550		
Spain	238, 260	491, 850	689, 630	246, 845		
Suez Canal		20, 500		10, 000		
Turkey	56, 750	72, 850	37, 300	79, 400		
United Kingdom	1, 412, 670	2, 634, 475	5, 037, 320	5, 830, 140	*a* 9, 674, 655	*a* 4, 321, 665
Other countries	1, 100	1, 000	26, 100	15, 250		
Total exports	11, 078, 845	12, 710, 120	37, 295, 210	37, 879, 540	34, 270, 990	30, 600, 790
Russia	687, 075	754, 745	1, 441, 165	1, 965, 200	51, 800	72, 450
Total shipments	11, 765, 920	13, 464, 865	38, 736, 375	39, 844, 740	34, 322, 790	30, 673, 240

a Illuminating distillate to United Kingdom was gas oil.

Shipments of petroleum products from Batum in the years 1898 and 1899—Continued.

[Gallons.]

To—	Refined.		Total.	
	1899.	1898.	1899.	1898.
Austria-Hungary	3,657,900	4,705,470	16,657,165	19,044,600
Belgium	6,562,280	8,106,380	19,173,650	20,036,905
Bulgaria	1,269,255	2,270,040	1,344,155	2,343,640
Cochin-China	5,401,000	758,400	5,401,000	758,400
China	28,709,250	9,076,480	28,709,250	9,076,480
Egypt	4,439,720	13,153,390	4,663,470	13,288,390
France	1,242,575	1,639,775	26,645,185	28,216,245
Germany	12,551,790	7,910,465	24,219,865	20,611,525
India	48,063,085	39,488,950	48,063,085	39,678,000
Italy	5,819,600	7,567,680	8,118,540	8,940,770
Japan	4,826,090	2,718,800	4,826,090	2,718,800
Java	8,672,320	5,198,840	8,672,320	5,198,840
Malta	1,369,775	1,475,835	1,369,775	1,475,835
Netherlands	2,124,905	2,071,805	2,228,405	2,076,805
Philippines	1,989,210	1,668,280	1,989,210	1,668,280
Roumania	479,175	423,200	568,025	566,750
Spain			927,890	738,695
Suez Canal	46,233,340	55,730,190	46,233,340	55,760,690
Turkey	19,786,240	28,730,005	19,880,290	28,882,255
United Kingdom	55,932,875	41,572,465	72,057,520	54,358,745
Other countries	5,479,590	1,902,300	5,506,790	1,919,550
Total exports	264,609,975	236,168,750	347,255,020	317,359,200
Russia	20,907,815	27,596,940	23,087,855	30,389,335
Total shipments	285,517,790	263,765,690	370,342,875	347,748,535

STOCKS AT BAKU.

The following table gives the stocks of crude petroleum at the wells and refineries, and the total stocks of illuminating, lubricating, and residuum at Baku at the close of 1898 and 1899, taken from the report of Mr. Chambers:

Stocks of all products at Baku.

[Barrels of 42 gallons.]

Product.	January 1— 1899.	1900.	Increase.	Decrease.
Crude:				
At wells	859,584	858,238		1,346
At refineries	1,462,344	4,750,359	3,288,015	
Total crude	2,321,928	5,608,597	3,286,669	
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
Illuminating	51,805,615	92,600,025	40,794,410	
Lubricating	11,605,275	9,009,485		2,595,790
Residuum	265,121,885	189,541,720		75,580,165

SHIPMENTS FROM NOVOROSSISK IN 1899.

The following table exhibits the shipments of petroleum products to different countries from Novorossisk during 1899:

Shipments of petroleum products from Novorossisk in 1899.

[Gallons.]

To—	Residuum.	Distillate.	Refined.	Total.
Belgium			2,208,945	2,208,945
France	263,560	3,017,700		3,281,260
Germany	916,845		3,788,445	4,705,290
Italy			3,081,915	3,081,915
Malta			594,080	594,080
Netherlands			928,780	928,780
Port Said			13,849,965	13,849,965
Trieste			1,288,390	1,288,390
United Kingdom	2,984,695	1,861,010	7,765,450	12,611,155
Total export	4,165,100	4,878,710	33,505,970	42,549,780
Russia	4,036,000		4,779,605	8,815,605
Total shipments	8,201,100	4,878,710	38,285,575	51,365,385

NOTE.—The "distillate" to France was illuminating distillate, while that to United Kingdom was gas oil. There were no shipments of any importance from Novorossisk in 1898.

As before stated, there are two routes from Baku to the Black Sea, a direct route by rail to Batum, and another by the Caspian Sea to Petrovsk, and thence by railroad to Novorossisk. The shipments at this port are only about 15 per cent of those at Batum.

PRICES.

The average monthly prices for petroleum products at Baku during 1899 were as follows. The prices are given in kopecks per pood:

Average monthly prices of petroleum products at Baku in 1899.

[Kopecks per pood.]

Month.	Refined oil.		Residuals.	Crude.
	Inland.	Export.		
January	$16\frac{3}{4}$	$23\frac{1}{2}$	$12\frac{3}{8}$	$11\frac{7}{8}$
February	16	$22\frac{1}{2}$	$12\frac{1}{2}$	12
March	16	$16\frac{1}{2}$	$12\frac{5}{8}$	$12\frac{3}{8}$
April	16	$16\frac{1}{2}$	$12\frac{1}{2}$	$12\frac{1}{4}$
May	19	$19\frac{3}{8}$	$12\frac{1}{2}$	$15\frac{1}{4}$
June	20	$22\frac{5}{8}$	$12\frac{5}{8}$	$13\frac{1}{16}$
July	$21\frac{1}{16}$	$22\frac{1}{8}$	13	$13\frac{3}{16}$
August	24	$25\frac{3}{4}$	$14\frac{1}{4}$	$14\frac{3}{4}$
September	$24\frac{3}{8}$	$24\frac{9}{16}$	$13\frac{7}{8}$	$15\frac{1}{8}$
October	$27\frac{5}{16}$	30	$13\frac{5}{8}$	$15\frac{1}{2}$
November	$33\frac{7}{16}$	$38\frac{11}{16}$	$13\frac{3}{4}$	$16\frac{15}{16}$
December	$31\frac{1}{8}$	$47\frac{1}{2}$	$14\frac{7}{8}$	$17\frac{1}{16}$

The following are the approximate values at Baku, allowing 8.18 poods to one barrel and 0.515 cents to one kopeck, for the first and last month of 1899:

Approximate values per barrel of Baku oil.

Month.	Refined oil.		Crude.
	Inland.	Export.	
January	\$0.70	\$0.99	\$0.50
December	1.31	2.00	.72

LIQUID FUEL ON RUSSIAN RAILWAYS.

The large and growing consumption of petroleum for fuel on the railways of Russia from 1886 to 1896 is shown in the following table:

Amount of petroleum used for locomotive fuel in Russia, 1886 to 1896.

Year.	Poods.	Barrels.	Year.	Poods.	Barrels.
1886....	5, 788, 505	707, 641	1892....	24, 881, 665	3, 041, 768
1887....	6, 741, 009	824, 084	1893....	27, 639, 252	3, 378, 881
1888....	8, 707, 569	1, 064, 495	1894....	37, 303, 670	4, 560, 351
1889....	12, 994, 112	1, 588, 522	1895....	50, 246, 071	6, 142, 551
1890....	17, 654, 607	2, 158, 265	1896....	62, 579, 141	7, 650, 262
1891....	20, 393, 703	2, 493, 130			

The consumption in the year 1896, as shown in the table, attained a total of over 1,000,000 tons, equivalent to more than 2,000,000 tons of coal.

THE GROSNI FIELD.

Regarding the Grosni field in the Caucasus, Mr. Chambers reports as follows:

A report upon the Russian oil trade which omitted mention of the Grosni field would be incomplete, although that field has little importance from an American point of view, as up to the present, notwithstanding the first big well in this field was struck in 1893, the amount of products which it has furnished to the world has been too insignificant to be worthy of attention. In fact, notwithstanding the production of this field has averaged probably 6,000 barrels per day for several years, it has hardly made itself felt even in Russia. Last year one of the refineries at Grosni, constructed especially for running crude to Grosni, was kept running with crude from Baku, which must have cost at Grosni not less than 20 kopecks (10.1 cents) per pood, while I do not think the local crude was ever quoted above 12 to 13 kopecks per pood (6.18 to 6.6 cents per 36 pounds).

I have not been able to obtain as accurate statistics of the Grosni production as for that of Baku; but such figures as I have obtained show that, notwithstanding the considerable amount of drilling done in 1899, resulting in 15 more producing wells in December of that year than in December of 1898, there was practically no increase in the production, the figures being 2,200,000 barrels for 1898 and 2,300,000 barrels for 1899. From a very good source, I get the following information as to the number of wells producing, idle, drilling, and undergoing repairs on December 31, 1899, which I give in comparison with the estimate for the same date in 1898:

Condition of wells at Grosni at the close of 1898 and 1899.

Description.	December 31— 1898.	December 31— 1899.
Wells producing	26	41
Wells idle	13	12
Wells drilling	24	38
Wells repairing	1	9
Derricks ready	10	14

AUSTRIA-HUNGARY.

GALICIA.

Galicia (formerly a part of Poland) is one of the provinces of the Austria-Hungarian monarchy, and is the only division of the Austrian confederation that furnishes crude petroleum. The producing areas follow the flanks of the Carpathian Mountains in a northwest direction, with more or less interruptions, for over 200 miles. Discoveries of petroleum on the southeast side of the crest of these mountains, in Hungary, have from time to time been reported, but so far only a few barrels have been produced.

The strata that furnish the petroleum in Galicia are the newer formations from the Cretaceous up to the Miocene. The strata and conditions in which petroleum is found in this country have much in common with the conditions in which it exists in California.

The production could only be obtained for the first half of 1899. This was 1,321,606 barrels, and ought to bring the total for 1899 up to 2,600,000 barrels, in which case the output will surpass the record of any previous year. It would show an increase of about 225,000 barrels over 1898. All the crude petroleum is refined at the numerous refineries scattered over the fields, the principal ones being at Peczenizya, Drohobycz, and Maryampolski.

The specific gravity of the petroleum ranges from 0.82 to 0.86, or 40° to 32° Baumé. Much of it contains paraffin; some of it a large percentage, others only a trace, while a portion has none whatever. The petroleum produced in eastern Galicia contains the most paraffin. Drilling in this section is slow and attended with considerable difficulty because of the steep dips, uncemented sand, and putty clay. In numerous instances a well will start with 24-inch riveted casing and have 8 to 10 strings telescoped before it is completed. A large number of wells are undercut by an expansion bit and the casing driven down close to the bit. Occasional spouting or flowing wells are found, but they are usually short-lived. Nearly all of the petroleum is raised by working barrels and valves, operated by complete systems of power plants, and as many as 50 to 100 wells are pumped by a single engine.

What is known as the Canadian pole system of drilling is in most general use. There are many hand-dug wells also operated in localities where the conditions are favorable.

The district of Drohobycz, which includes Schodnica, Urycz, and Boryslaw, produces two-thirds of the entire output; there were 579 wells producing at the close of June, 1899; of this number 14 were hand-dug shafts, the remainder being "machine drilled," that is, drilled with machinery. The amount of crude petroleum produced in Galicia does

not supply the demand of Austria-Hungary, as there were 107,353 barrels of illuminating and lubricating oils imported from the United States in 1899, together with 396,600 barrels from Russia, of which 98,700 barrels were crude, a part of which went to Galicia. There were also imported from Roumania to Galicia about 150,000 barrels of petroleum at a special reduced duty. The total imports into Austria-Hungary exceed 500,000 barrels a year. In spite of this there is a considerable amount of lubricating and illuminating oil exported to Germany from Galicia. The ozocerite or solid paraffin mined at Boryslaw is exported to Germany, Russia, and other countries.

Production of crude petroleum in Galicia in 1898 and first half of 1899.

District.	1898.		1899. *a*	
	Metric centners.	Barrels of 42 gallons.	Metric centners.	Barrels of 42 gallons.
Drohobycz	2,200,780	1,582,471	1,191,490	856,741
Jasielski	966,850	695,213	596,770	429,107
Stanislau	106,870	76,845	49,730	35,758
Other districts	30,010	21,579		
Total	3,304,510	2,376,108	1,837,990	1,321,606

a First half of year.

The following equivalents of value, weight, and length are given:

1 florin or gulden=48.2 cents.
1 metric ton=2,204.62 pounds.
1 metric ton=7.1905 barrels of crude petroleum of 42 gallons.
1 metric centner / 1 quintal }=100 kilos (220.462 pounds).
1 kilo=2.20462 pounds.
1 gallon refined petroleum=6.6 pounds.
1 gallon crude petroleum=7.3 pounds.
1 quintal or 1 metric centner of refined petroleum=0.795317 barrel of 42 gallons.
1 quintal or 1 metric centner of crude petroleum=0.71905 barrel of 42 gallons.
1 kilometer=3,280.89 feet=0.6213 mile.

In the following table is given a statement of the production of crude petroleum in Galicia from 1886 to 1899, inclusive, as ascertained by the Statistical Bureau of the Galizischer Landes-Petroluem-Verein, Lemberg:

Production of crude petroleum in Galicia from 1886 to 1899.

Year.	Metric centners.	Barrels of 42 gallons.	Year.	Metric centners.	Barrels of 42 gallons.
1886	425,400	305,884	1893	963,312	692,669
1887	478,176	343,832	1894	1,320,000	949,146
1888	648,824	466,537	1895	2,020,720	1,452,999
1889	716,595	515,268	1896	3,397,650	2,443,080
1890	916,504	659,012	1897	3,096,263	2,226,368
1891	877,174	630,732	1898	3,304,510	2,376,108
1892	898,713	646,220	1899 *a*	1,837,990	1,321,606

a First half of year.

Record of wells and tankage capacity in Galicia in 1898 and first half of 1899.

WELL RECORD AND TANKAGE CAPACITY FOR YEAR 1898.

District.	Well record.					Tankage capacity.
	Machine drilled.	Hand dug.	Producing.	Wells drilling.	Total.	*Metric centners.*
Drohobycz	675	25	490	210	700	1,167,670
Jasielski	854	19	756	117	873	628,890
Stanislau	52	115	151	16	167	16,840
Total	1,581	159	1,397	343	1,740	1,813,400

WELL RECORD AND TANKAGE CAPACITY FIRST HALF OF 1899.

District.	Well record.					Tankage capacity.
	Machine drilled.	Hand dug.	Producing.	Wells drilling.	Total.	*Metric centners.*
Drohobycz	689	14	579	124	703	1,167,680
Jasielski	923	17	794	146	940	645,970
Stanislau	67	59	103	23	126	19,570
Total	1,679	90	1,476	293	1,769	1,833,220

Statistics of the consumption of refined petroleum in Austria-Hungary from 1888 to 1899.

[Metric centners.]

Year.	Production of refineries. Galicia and Bukovina.	Other provinces of Austria.	Hungary and Bosnia.	Total production.	Imported from foreign countries.	Total consumption of Austria-Hungary.	Increase in consumption.
							Per cent.
1888	406,447	237,703	756,257	1,400,407	72,816	1,473,223	....
1889	428,147	243,595	778,996	1,450,732	78,253	1,528,991	3.79
1890	400,611	324,921	767,195	1,492,727	75,445	1,568,172	2.56
1891	413,486	396,307	814,960	1,624,758	79,676	1,704,429	8.68
1892	408,506	446,008	801,849	1,656,364	50,161	1,706,524	.12
1893	408,297	534,915	787,329	1,730,541	43,870	1,774,411	3.98
1894	442,616	616,167	861,615	1,920,398	48,968	1,969,366	10.99
1895	482,798	582,964	898,648	1,964,410	46,325	2,010,735	2.10
1896	573,338	530,304	960,488	2,064,130	44,800	2,108,930	4.88
1897	563,605	769,945	821,827	2,155,377	48,852	2,204,229	4.52
1898	....	....	....	2,218,960	44,080	2,263,040	2.67
1899 *a*	....	....	....	1,016,850	24,070	1,040,920	....

a First half of year.

The two following tables are taken from the "Statistisches Jahrbuch k. k. Ackerbau-Ministeriums," and give statistics of petroleum industry in Galicia, 1894 to 1898:

Production of crude petroleum in Galicia from 1894 to 1898.

Chief mining division and mining district.	Number of laborers (including overseers). Men.	Women.	Youths.	Total.
Krakow:				
Jaslo	2,781	5	3	2,789
Drohobycz	2,725	....	....	2,725
Stanislau	385	....	3	388
Total for 1898	5,891	5	6	5,902
1897	5,525	5	7	5,537
1896	4,517	5	....	4,522
1895	4,318	5	....	4,323
1894	3,270	31	3	3,304

Production of crude petroleum in Galicia from 1894 to 1898—Continued.

Chief mining division and mining district.	Production (metric centners).				Total value.
	From mine grants.	From naphtha fields.	Other.	Total.	
Krakow:					*Florins.*
Jaslo	95,249	17,081	854,527	966,857	2,616,614
Drohobycz		172,700	1,996,774	a2,169,474	a5,352,509
Stanislau			95,089	b95,089	b242,818
Total for 1898	95,249	189,781	2,946,390	3,231,420	8,211,941
1897	97,102	18,952	2,635,985	2,752,039	5,876,692
1896	96,002	29,617	2,497,945	2,623,564	5,188,855
1895	105,348	83,110	1,697,886	1,886,344	4,464,353
1894	102,585	104,649	912,068	1,119,302	3,252,554

a Of this 232 quintals, worth 636 fl., were obtained as by-products of the ozocerite industry.
b Of this 1,970 quintals, worth 4,025 fl., were obtained as by-products of the ozocerite industry.

Well records in Galicia, 1894 to 1898.

Chief mining division and mining district.	Shafts.			Drill holes.			
	Total.	In course of excavation.	Oil producing.	Total.	In course of excavation.	Oil producing.	
						Hand power.	Steam power.
Krakow:							
Jaslo	a539	10	35	b1,459	c117	148	d608
Drohobycz	e21	1	10	f774	g142	25	h495
Stanislau				i183	14	10	j121
Total for 1898	560	11	45	2,416	273	183	1,224
1897	571	10	37	2,223	264	185	1,099
1896	592	12	50	1,974	237	169	1,016
1895	706	13	82	1,895	209	189	911
1894	673	20	82	1,614	181	199	744

a Of these 494 were idle.
b Of these 10 were nailed up and 576 were idle. Of the latter 173 were abandoned temporarily and 403 were entirely abandoned.
c Of these 19 in course of excavation by hand power and 98 by steam power.
d Of these 8 flowed of their own accord.
e Of these 10 were entirely abandoned.
f Of these 27 were idle, 50 entirely abandoned, 22 filled up, and 13 nailed up.
g All with machinery.
h 18 flowed of their own accord.
i Of these 38 were idle.
j Of these 7 flowed of their own accord.

Well records in Galicia, 1894 to 1898—Continued.

Chief mining division and mining district.	Pipe lines.		Oil tanks.	
	Iron.	Wood.	Iron.	Wood.
Krakow:	*Meters.*	*Meters.*		
Jaslo	*a* 112, 875	....	*b* 102	*c* 604
Drohobycz	*d* 130, 374	....	*e* 63	*f* 638
Stanislau	*g* 8, 136	....	*h* 6	*i* 161
Total for 1898	251, 385	....	171	1, 403
1897	243, 640	....	142	1, 154
1896	218, 385	50	137	1, 068
1895	166, 492	50	92	949
1894	110, 724	100	66	676

a There were also 30,914 meters of gas pipe, 10,450 meters of steam pipe, 36,954 meters of water pipe, and 176,824 meters of pump tubes.

b Capacity, 12,914 cubic meters.

c Capacity, 10,114 cubic meters.

d There were also 26,940 meters of gas pipe, 10,018 meters of steam pipe, 43,834 meters of water pipe, and 179,638 meters of pump tubes.

e Capacity, 54,276 cubic meters.

f Capacity, 11,846 cubic meters.

g There were also 1,972 meters gas pipe, 175 meters steam pipe, 2,340 meters water pipe, and 29,599 meters pump tubes.

h Capacity, 482 cubic meters.

i Capacity, 1,104 cubic meters.

Quantity and value of petroleum exported from the United States to Austria-Hungary in year ending June 30, 1899.

Kind of oil.	Quantity.	Value.
	Gallons.	
Crude oil	996, 809	$38, 977
Lubricating oil	641, 675	68, 376

ROUMANIA.

The localities in which petroleum is found lie along the flanks of the Carpathian Mountains and are similar to the positions of the petroleum fields of Galicia, which it joins on the south.

These mountains after running southeast, separating Roumania and Hungary, swing to the south and then southwest to west. The core of the mountains is composed of igneous rock; following down their flanks the newer formations are seen and the Cretaceous, the Eocene, Miocene, and Pliocene, followed by the Quaternary of the plain, occur in succession. The violent folding of the mountain region grows less as the plain is approached until a series of anticlinals and synclinals are observed.

This condition follows the flanks of the mountains with their changing direction for nearly 200 miles. Nowhere is there a long continued line of development found so far as present operations go. Near the crest of the anticlinals the early shafts were sunk by hand, prospectors being attracted to these locations by the existence of springs of petroleum. The dip of the strata holding petroleum along the flanks of these anticlinals varies from 15° to 60°. The petroleum is generally found in a loosely cemented sandstone—Miocene and Cretaceous formations, more generally in the former—from 5 to 35 feet in thickness. The covering is a thick stratum of blue, tough clay which alternates with shales and small crystals of gypsum. In other localities more or less rock salt is found in the clay overlying the petroleum-bearing stratum of sand.

Some of the petroleum shafts are 600 feet in depth and 1 meter square. It requires two or three years to put them down to this depth, as only one man can work at the bottom, and all of the material has to be hoisted over his head in a bucket operated by a hand windlass. A second rope is attached to the body of the workman in the shaft, so that he can be drawn up in case there should be a sudden rush of gas or petroleum. Air is carried down in a tin tube fastened to the corner of the shaft. It is compressed by an immense pair of bellows operated by hand at the top. The sides are secured by light timber. In some localities the water, quicksand, and yielding clay completely prevent this method.

The Canadian system of rods is usually used in the wells drilled by machinery, although there are some drilled by cable. The soft, yielding nature of the material usually encountered demands a series of casings beginning with, say, 24-inch down to 8-inch telescoped, or the use of an undercutting reamer closely followed by the casing.

The depths of the shafts or pits producing petroleum range from 120 to 750 feet, and the drilled wells from 600 to 2,000 feet.

The total number of shafts producing in 1899 was 620. The number of drilled wells producing was 51 and these produced 60 per cent of the output.

By far the largest producing section is that of Prahova which is made up of the districts of Campina, Glodeni, Dolftana, and Bustenari, from which two-thirds of the entire production is obtained.

The entire output is placed in round numbers at 210,000 tons, which, reckoned at 7 barrels to the ton, amounts to 1,470,000 barrels. Of this amount 70,000 tons (500,000 barrels), are used at the refineries, 500,000 barrels are exported to Austria-Hungary, and 470,000 barrels are consumed as liquid fuel by the factories and different industries, a considerable amount being used on locomotives. There are 125 kilometers, equal to 77.5 miles, of pipe lines connecting the various fields with the railroads, although a large amount of petroleum is delivered to the

refineries in tank wagons as well as by local lines. The Sterna Romana Refining Company, of Campina, with their refineries at Campina, Bukharest, Moinesti, and Monteosa have a joint capacity of 1,500 barrels per day. There are 8 to 10 refineries that have a capacity of from 70 to 550 barrels per day, besides there are about 75 smaller refineries that run temporarily or in the winter season only.

The price of crude petroleum at the wells ranged from 1.35 francs to 2 francs per 100 kilos, or from 36 to 58 cents per barrel during 1899. There were exported from Batum, Russia, 13,527 barrels of petroleum and other grades of oil in 1898 by way of the Danube River. From an inspection of the following tables it will be seen that the production in 1899 was 85 per cent greater than that of 1898, and amounted to 1,425,777 barrels. Other reports show a larger increase. The greatest increase comes from the district of Campina, where a number of large wells were developed.

The following statement, furnished by the Imperial and Royal Austro-Hungarian consulate in Plojest, gives the production of crude pretroleum in Roumania in 1896, 1897, 1898, and 1899.

Production of crude petroleum in Roumania in 1896, 1897, 1898, and 1899.

[Tank carloads of 100 metric centners.]

Locality.	Production.			
	1896.	1897.	1898.	1899.
Baicoi	250	250	340	800
Glodeni	1, 365	350	1, 925	2, 300
Campina	300	1, 460	2, 650	8, 500
Dolftana and Bustenari	2, 960	3, 830	2, 730	3, 860
Ochisori and Matitza	178	150	160	380
Sarata (Buzeu) / Tega	902	700	1, 185	1, 890
Other localities	1, 602	1, 200	1, 667	2, 100
Total	7, 557	7, 940	10, 657	19, 830

In the following table will be found the production of crude petroleum in the principal districts in Roumania from 1874 to 1899, inclusive:

Production of crude petroleum in Roumania from 1874 to 1899.

[Metric ton crude=7.19 barrels.]

Year.	District.				Total.	
	Prahova.	Buzeu.	Bacau.	Dimbovitza.	Tank cars.	Barrels (42 U. S. gallons).
1874	155	780	220	280	1,435	103,176.5
1875	160	820	230	300	1,510	108,569
1876	150	760	280	320	1,510	108,569
1877	180	760	250	320	1,510	108,569
1878	210	750	250	300	1,510	108,569
1879	250	700	280	300	1,530	110,007
1880	290	710	300	290	1,590	114,321
1881	350	740	300	300	1,690	121,511
1882	540	700	310	350	1,900	136,610
1883	570	700	320	350	1,940	139,486
1884	1,560	700	300	370	2,930	210,667
1885	1,350	700	300	340	2,690	193,411
1886	880	750	290	425	2,345	168,605.5
1887	950	800	280	500	2,530	181,907
1888	890	840	360	950	3,040	218,576
1889	950	1,010	380	1,800	4,140	297,666
1890	1,030	1,100	600	2,600	5,330	383,227
1891	1,150	1,050	790	3,800	6,790	488,201
1892	1,600	1,100	850	4,700	8,250	593,175
1893	1,700	950	1,300	3,500	7,450	535,655
1894	2,600	925	1,650	1,880	7,055	507,254.5
1895	3,714	904	1,838	1,544	8,000	575,200
1896	3,688	902	1,602	1,365	7,557	543,348
1897	5,690	700	1,200	350	7,940	570,886
1898	5,880	1,185	1,667	1,925	10,657	766,238
1899	13,540	1,890	2,100	2,300	19,830	1,425,777

Another report places the production of Roumania for 1899 as follows:

District and subdistrict.	Metric tons.	Barrels.
Prahova:		
Campina		
Bustenari		
Poiana	224,000	1,568,000
Dolftana		
Godeni		
Dolftana:		
Gura Ocnita		
Calibasi	35,000	245,000
Bacau:		
Solontu		
Moinesti	14,600	102,200
Buzeu:		
Sarata		
Berea	12,500	87,500
Total	286,100	2,002,700

GERMANY.

The production in Germany during 1899 was 192,232 barrels, equal to 560 barrels per day, as compared with 183,424 barrels in 1898, a gain of 8,808 barrels, or 5 per cent. Most of this gain comes from the increased production in the fields near Hanover, in Prussia, which produced 24,029 barrels in 1899, as compared with 18,102 barrels in 1898. The remainder, 168,203 barrels, was produced in Alsace. The average price received in 1899 was $1.97 per barrel, as compared with $2.06 per barrel in 1898.

The petroleum in Alsace is produced from wells, from 130 to 500 meters deep. It is very dark in color and of 28° gravity (0.876), and carries 15 to 20 per cent of water, nearly all of which is separated from it at the wells by steam heat.

The refineries are located at Pechelbronn and Bodromstein, in Alsace, and at Pine, near Hanover. The former refineries secure from 22 to 25 per cent of light products, as compared with 15 to 18 per cent secured at Pine. Both of these refineries manufacture a large percentage of superior lubricating oil. The import duty of 6 marks per 100 kilos ($1.43 per barrel) on illuminating and 10 marks per 100 kilos ($2.38 per barrel) on lubricating oils gives the oils of

domestic production a decided advantage. This is especially true of lubricating oils.

The proportion of the petroleum produced in Germany is insignificant when compared to that imported from the United States, which for the year ending June 30, 1899, was 131,560,146 gallons, or 3,132,384 barrels of all grades, as compared with about 85,000 barrels of oil manufactured in Germany. This is in the proportion of 37 barrels imported from the United States to 1 barrel produced in Germany.

Russia exported into Germany about one-sixth of the amount exported from the United States. In the order of the quantity and value of petroleum and its products imported Germany stands third, being surpassed by the United Kingdom and the Netherlands.

The production of petroleum in Germany from 1890 to 1899 is shown in the following table:

Production of petroleum in Germany from 1890 to 1899, inclusive.

Year.	Production.	
	Metric tons. (*a*)	Barrels (42 gallons).
1890	15,226	108,295
1891	15,315	108,927
1892	14,257	103,323
1893	13,974	99,395
1894	17,232	122,563
1895	17,051	121,277
1896	20,395	145,061
1897	23,303	165,743
1898	25,789	183,424
1899	27,027	192,232

a One ton crude = 7.1126 barrels.

The following table shows the amount and value of petroleum produced in the German Empire from 1894 to 1899, by States:

Production and value of petroleum in the German Empire from 1894 to 1899.

[1 mark=24 cents.]

State.	Quantity.		Value.	
	Metric tons.	Barrels.	Marks.	Dollars.
1894.				
Alsace-Lorraine	15,632	111,183	813,284	195,188
Prussia	1,600	11,380	159,163	38,199
Total	17,232	122,563	972,447	233,387
1895.				
Alsace-Lorraine	15,439	109,812	776,671	186,401
Prussia	1,612	11,465	185,784	44,588
Total	17,051	121,277	962,455	230,989
1896.				
Alsace-Lorraine	18,883	134,310	1,001,042	240,250
Prussia	1,512	10,751	187,469	44,993
Total	20,395	145,061	1,188,511	285,243
1897.				
Alsace-Lorraine	20,703	147,250	1,104,291	265,030
Prussia	2,600	18,493	292,153	70,117
Total	23,303	165,743	1,396,444	335,147
1898.				
Alsace-Lorraine, Bavaria	23,244	165,322	1,296,157	311,078
Prussia	2,545	18,102	282,051	67,692
Total	25,789	183,424	1,578,208	378,770
1899.				
Alsace-Lorraine, Bavaria	23,649	168,203	....	....
Prussia	3,378	24,029	....	....
Total	27,027	192,232	1,577,456	378,589

In the following table is given a statement of the exports of petroleum to Germany from the United States from 1890 to 1899:

Exports of petroleum to Germany from the United States from 1890 to 1899.

[Gallons.]

Year ending June 30—	Crude.	Refined.		
		Naphthas.	Illuminating.	Lubricating.
1890	1, 188, 266	2, 015, 298	140, 264, 082	3, 670, 937
1891	3, 107, 137	3, 227, 106	162, 187, 071	4, 186, 225
1892	5, 247, 209	3, 471, 652	133, 417, 314	4, 512, 639
1893	4, 182, 963	4, 127, 354	119, 277, 484	3, 798, 953
1894	4, 877, 593	4, 278, 757	86, 388, 785	5, 637, 471
1895	3, 966, 870	4, 900, 028	100, 829, 413	5, 378, 398
1896	817, 212	2, 814, 217	121, 841, 266	5, 990, 561
1897	2, 430, 249	2, 800, 883	114, 583, 356	6, 877, 196
1898	3, 585, 777	6, 135, 309	137, 981, 137	8, 086, 776
1899	3, 485, 360	4, 716, 306	115, 124, 570	8, 233, 910

The total number of gallons exported for the year ending June 30, 1899, from the United States to Germany was 131,560,146, amounting to $6,682,348 at the port of export.

PETROLEUM IN HAMBURG IN 1898.

Hamburg's importation of petroleum showed an extraordinary increase in 1898. Imports by way of the ocean in the last ten years have been as follows:

Imports of petroleum into Hamburg, Germany.

Year.	Double centners of 220 pounds.	Value.	Year.	Double centners of 220 pounds.	Value.
1889	1, 110, 099	$3, 500, 000	1894	949, 763	$2, 000, 000
1890	1, 162, 198	3, 500, 000	1895	1, 308, 872	3, 700, 000
1891	785, 909	2, 300, 000	1896	1, 460, 331	3, 900, 000
1892	694, 093	1, 900, 000	1897	2, 082, 528	4, 300, 000
1893	796, 619	1, 700, 000	1898	3, 046, 661	7, 500, 000

The countries from which petroleum was imported into Hamburg during 1898 are shown in the following table:

Petroleum imported into Hamburg in 1898.

From—	Kilos.
United States of America	280, 465, 900
Russia	23, 728, 400
Bremen	462, 000
Other countries	9, 800
Total	304, 666, 100

From the United States the imports amounted to $6,900,000, against $3,900,000 in 1897. The imports from Russian ports on the Black Sea have also increased somewhat; viz, in 1897 they were $378,420; in 1898, $499,800.

The average prices for petroleum in the last ten years have been as follows, per double centner of 220 pounds:

Prices of petroleum in Hamburg from 1889 to 1898.

[Per double centner.]

Year.	Price.	Year.	Price.
1889	$3. 11	1894	$2. 16
1890	3. 02	1895	2. 87
1891	2. 95	1896	2. 68
1892	2. 73	1897	2. 10
1893	2. 18	1898	2. 49

The value of the imports of American petroleum into Germany by way of the ocean were:

1898	$7, 247, 000
1897	4, 163, 000
Increase in 1898	3, 084, 000

Imports from all sources to and exports from Germany in 1897, 1898, and 1899.

[In 100 kilos.]

Description of oil.	1897.		1898.		1899.	
	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.
Refined oil:						
Foreign	8, 741, 754	380	8, 896, 747	527	8, 971, 750	343
Home	....	15, 121	....	12, 199	....	10, 582
Other petroleum distillates:						
Foreign	52, 917	660	56, 239	710	81, 085	2, 115
Home	....	36, 821	....	40, 381	....	34, 541
Lubricating oils:						
Foreign	839, 566	34, 342	970, 280	13, 436	1, 066, 243	11, 982
Home	....	4, 345	....	8, 747	....	9, 669
Crude oil	151, 442	21	103, 914	24	57, 853	54
Mineral oils for industrial purposes	31, 054	....	31, 555	....	31, 552	....
Mineral oils for distilling, refining, etc	517, 331	....	489, 560	....	528, 742	....
Heavy coal-tar oils	24, 861	38, 629	19, 990	64, 234	25, 426	86, 404
Coal tar, peat, and shale	582	65	756	23	930	88

1,000 kilos=1 metric ton=2,205 pounds.
100 kilos=0.8 barrel—for refined petroleum (approximate).
100 kilos=0.7 barrel—for crude petroleum (approximate).

The following table gives the value of all the petroleum imported into and exported from Germany during 1896 and 1897, as reported by the consul-general at Frankfort:

Value of petroleum imported into and exported from Germany in 1896 and 1897.

Year.	Imports.	Exports.
1896	$19, 268, 242	$315, 350
1897	19, 373, 676	461, 482

AVERAGE WHOLESALE PRICES FOR PETROLEUM IN GERMANY FOR EACH MONTH OF THE YEAR 1899, AND FOR EACH YEAR FROM 1879.

The Chemiker Zeitung gives the following particulars in regard to the average wholesale prices for petroleum at different towns in Germany:

Average wholesale prices for petroleum in Germany.

[Price in marks per 100 kilos, including barrel.]

Month and year.	Standard white oil.					
	Bremen (duty free).	Breslau.	Danzig.	Hamburg (duty free).	Cologne.	Magdeburg.
1899.						
January	13.98	22.40	22.10	13.82	23.55	22.60
February	13.89	22.00	22.50	13.80	23.45	22.30
March	13.68	21.70	21.70	13.77	23.07	21.90
April	12.70	21.25	20.90	12.78	22.28	21.05
May	12.48	20.86	21.20	12.28	21.87	20.75
June	12.90	21.20	21.00	12.72	22.35	20.95
July	13.52	22.10	21.90	13.22	23.10	21.60
August	14.11	22.65	22.20	13.90	23.55	22.60
September	15.32	23.50	23.90	15.04	24.90	23.50
October	15.94	24.30	24.50	15.72	25.65	24.00
November	16.36	24.90	25.00	16.15	25.83	24.70
December	16.83	25.35	25.40	16.64	26.70	25.45
Year—						
1899	14.3	22.7	22.7	14.2	23.90	22.6
1898	12.1	....	20.7	11.8	....	....
1897	10.7	....	20.0	10.5	....	....
1896	12.4	....	21.6	12.5	....	....
1895	13.5	....	22.6	13.6	....	....
1894	9.7	....	19.1	10.0	....	....
1893	9.5	....	19.3	9.8	....	....
1892	11.1	....	21.5	11.7	....	....
1891	12.6	....	23.1	12.9	....	....
1890	13.3	....	24.2	13.4	....	....
1889	13.7	....	25.1	14.0	....	....
1888	14.7	....	26.0	14.8	....	....
1887	12.5	....	22.2	12.7	....	....
1886	13.1	....	23.6	13.6	....	....
1885	14.5	....	23.7	14.9	....	....
1884	15.2	....	24.9	15.7	....	....
1883	15.5	....	24.7	15.8	....	....
1882	14.3	....	24.0	14.7	....	....
1881	15.8	....	26.6	16.1	....	....
1880	17.2	....	27.6	17.2	....	....
1879	16.3	....	23.0	16.9	....	....

Average wholesale prices for petroleum in Germany—Continued.

[Price in marks per 100 kilos, including barrel.]

Month and year.	Standard white oil.			Russian refined oil.	
	Mann-heim.	Posen.	Stettin.	Breslau.	Lubeck.
1899.					
January	22.35	23.95	21.80	20.00	20.90
February	22.00	23.60	21.60	19.50	20.50
March	21.70	23.30	21.40	20.00	20.50
April	20.57	22.40	20.20	20.00	19.50
May	20.35	21.75	20.30	20.00	19.20
June	20.90	22.00	20.70	20.00	19.60
July	21.53	22.70	21.40	20.00	20.20
August	22.10	23.10	22.00	20.50	20.90
September	23.40	24.30	23.20	21.00	22.00
October	23.90	24.90	23.80	21.40	22.70
November	24.45	25.30	24.10	21.40	23.20
December	25.25	26.15	24.70	22.00	23.60
Year—					
1899	22.4	23.6	22.1	20.5	21.1
1898			20.1	19.2	19.2
1897			18.8	18.7	18.7
1896			20.9	19.9	20.4
1895			22.2	21.2	22.0
1894			18.1	18.2	18.5
1893			18.3	19.0	19.4
1892			20.7	20.5	21.0
1891			22.1	21.3	22.2
1890				22.4	22.0
1889			24.1	22.8	22.7
1888			24.9		22.0
1887			21.9		22.0
1886			22.6		
1885			23.3		
1884			24.0		
1883			24.2		
1882			22.8		
1881			24.7		
1880			26.3		
1879			25.8		

ITALY.

The statistics of the Italian petroleum production for 1899 had not been given out at the time of the publication of this report. The industry, however, has never assumed large proportions, although the existence of oil has been known for centuries. The total production for 1898 was 14,489 barrels, as compared with 13,892 barrels in 1897 and 18,149 barrels in 1896. While the average price per barrel advanced from $6.84 in 1897 to $7.85 in 1898, it did not seem to stimulate developments very greatly or lead to the discovery of any new fields.

The duty on refined oil has been made very heavy in order to stimulate the production of crude petroleum and the manufacture of refined oil. The greater portion of Italy's supply of crude petroleum is obtained from Russia. The United States exported 21,671,324 gallons of petroleum to Italy in 1899, 20,667,000 gallons in 1898, and 25,800,000 gallons in 1897, upon which the excise duty of 10 lires ($1.93) per 100 kilos (220 pounds) amounted to $2.25 per barrel. There is also an import duty of 48 lires per 100 kilos, which is equal to $11.50 per barrel for refined petroleum.

PRODUCTION.

From the volumes of Rivista del Servizio Minerario the following statements are extracted regarding the production of crude and refined petroleum in this country:

Production of crude petroleum in Italy from 1860 to 1898.

Year.	Number of wells in operation.	Quantity.		Value.				Number of workmen employed.
		Metric tons	United States barrels.	Unit value.		Total value.		
				Lire.	Dollars.	Lire.	Dollars.	
1860..	3	5	36	800.00	21.44	4,400	772	5
1861..	3	4	29	800.00	21.31	3,200	618	8
1862..	4	4	29	800.00	21.31	3,200	618	9
1863..	7	8	58	800.00	21.29	6,400	1,235	18
1864..	7	10	72	800.00	21.41	8,000	1,544	32
1865..	10	315	2,265	209.52	5.62	66,000	12,738	70
1866..	12	138	992	269.86	7.24	37,240	7,187	57
1867..	11	110	791	349.10	9.37	38,400	7,411	58
1868..	9	51	367	435.29	11.67	22,200	4,285	52
1869..	8	20	144	800.00	21.65	16,000	3,118	45

Production of crude petroleum in Italy from 1860 to 1898—Continued.

Year.	Number of wells in operation.	Quantity.		Value.				Number of workmen employed.
		Metric tons.	United States barrels.	Unit value.		Total value.		
				Lire.	Dollars.	Lire.	Dollars.	
1870..	6	12	86	800.00	21.55	9,600	1,853	30
1871..	6	38	273	263.16	7.07	10,000	1,930	40
1872..	6	46	331	208.69	5.60	9,600	1,853	36
1873..	5	65	467	172.31	4.63	11,200	2,162	35
1874..	4	84	604	152.38	4.00	12,800	2,470	37
1875..	3	113	812	138.05	3.70	15,600	3,011	38
1876..	3	402	2,890	123.38	3.31	49,600	9,573	72
1877..	2	408	2,934	132.35	3.55	54,000	10,422	45
1878..	4	602	4,328	102.99	2.76	62,000	11,966	98
1879..	4	402	2,890	124.37	3.34	50,000	9,650	70
1880..	2	283	2,035	313.05	8.40	88,595	17,099	24
1881..	2	172	1,237	445.00	11.94	76,540	14,772	24
1882..	4	183	1,316	474.55	11.97	86,844	15,761	121
1883..	5	225	1,618	259.49	6.96	58,387	11,269	92
1884..	6	397	2,854	341.18	9.16	135,452	26,142	110
1885..	6	270	1,941	407.65	10.92	110,066	21,243	136
1886..	7	219	1,575	416.11	11.16	91,130	17,588	145
1887..	7	208	1,497	368.84	9.76	76,720	14,614	135
1888..	5	174	1,251	319.71	8.58	55,630	10,737	75
1889..	7	177	1,273	288.13	7.73	51,000	9,843	70
1890..	9	417	2,998	289.21	7.77	120,603	23,276	177
1891..	10	1,155	8,305	301.38	8.09	348,100	67,183	251
1892..	7	2,548	18,321	296.11	7.95	754,500	145,619	267
1893..	8	2,652	19,068	299.80	8.05	795,050	153,445	130
1894..	9	2,854	20,520	296.88	7.97	847,260	163,521	194
1895..	6	3,594	25,841	258.90	6.95	930,496	179,586	134
1896..	9	2,524	18,149	255.34	6.85	644,468	124,383	222
1897..	8	1,932	13,892	255.33	6.84	492,288	95,010	245
1898..	7	2,015	14,489	292.30	7.85	589,129	113,702	....

7.1905 barrels=1 metric ton of crude.
7.955 barrels=1 metric ton of refined.
1 lire=19.3 cents.

Production of crude petroleum in Italy in 1895, by districts.

Mining district.	Number of wells.	Production. Quantity. Metric tons.	Barrels of 42 gallons.	Value. Per ton.	Per barrel.	Total.	
				Lire.		*Lire.*	
Emilia	3	3,532	25,395	260.00	$6.98	918,320	$177,236
Roma	3	62	446	196.71	5.27	12,176	2,350
Total	6	3,594	25,841	258.90	6.95	930,496	179,586

Production of crude petroleum in Italy in 1896, by districts.

Mining district.	Province.	Number of wells.	Production. Quantity. Metric tons.	Barrels of 42 gallons.	Value. Per ton.	Per barrel.	Total.	
					Lire.		*Lire.*	
Bologna		1	1	7	250.00	$7.00	250	$48
Milano	Parma	5	61	439	273.00	7.34	16,682	3,220
	Piacenza	2	2,388	17,171	260.00	6.98	620,896	119,833
Roma	Chieti	1	74	532	89.73	2.41	6,640	1,282
Total		9	2,524	18,149	255.34	6.85	644,468	124,383

Production of crude petroleum in Italy in 1897, by districts.

Mining district.	Province.	Number of wells in operation.	Quantity. Metric tons.	Barrels of 42 gallons.	Value. Per ton.	Per barrel.	Total.	
					Lire.		*Lire.*	
Milano	Parma	5	80	575	260.00	$6.98	20,800	$4,014
	Piacenza	2	1,791	12,878	260.00	6.98	465,660	89,872
Roma	Chieti	1	61	439	95.44	2.56	5,822	1,124
Total		8	1,932	13,892	255.33	6.84	492,282	95,010

Production of crude petroleum in Italy in 1898, by districts.

Mining district.	Province.	Number of wells in operation.	Quantity.		Value.			
			Metric tons.	Barrels of 42 gallons.	Per ton.	Per barrel.	Total.	
					Lire.		*Lire.*	
Milano ..	Parma ..	6	45	324	269.20	$7.20	12,089	$2,333
	Piacenza		1,910	13,734	300.00	8.05	573,180	110,624
Roma ...	Chieti ...	1	60	431	64.33	1.73	3,860	745
Total.	....	7	2,015	14,489	292.30	7.85	589,129	113,702

Production of refined petroleum in Italy from 1890 to 1898.

Year.	Number of works.	Quantity.		Value.				Number of laborers.
		Metric tons.	Barrels of 42 gallons.	Per ton.	Per barrel.	Total.		
				Lire.		*Lire.*		
1890..	4	350	2,784	600.00	$14.56	210,000	$40,530	44
1891..	4	813	6,467	457.86	11.11	372,242	71,843	55
1892..	5	1,573	12,513	491.08	11.91	772,474	149,087	65
1893..	4	2,613	20,786	494.98	12.01	1,293,380	249,622	57
1894..	2	1,640	13,046	590.00	14.31	967,600	186,747	34
1895..	3	4,191	33,339	526.07	12.76	2,204,764	425,520	61
1896..	3	2,734	21,747	541.66	13.14	1,480,737	285,782	34
1897..	12	3,392	26,983	412.05	10.00	1,397,667	269,750	90
1898..	11	5,040	40,093	393.19	9.53	1,979,105	381,967	98

Production of refined petroleum, benzine, and gasoline in Italy in 1895, by districts.

Mining district.	Province.	Number of works in operation.	Production.						Number of laborers.
			Quantity.		Value.				
			Metric tons.	Barrels of 42 gallons.	Per ton.	Per barrel.	Total.		
					Lire.		*Lire.*		
Milano ...	Parma	2	4,185	33,291	526.03	$12.76	2,201,464	$424,883	50
	Piacenza								
Roma	Chieti	1	6	48	550.00	13.27	3,300	637	11
Total...	....	3	4,191	33,339	526.07	12.76	2,204,764	425,520	61

Production of refined petroleum in Italy in 1896, by districts.

Mining district.	Province.	Number of works.	Kind of product.	Production.						Number of laborers.
				Quantity.		Value.				
				Metric tons.	Barrels of 42 gallons.	Per ton.	Per barrel.	Total.		
						Lire.		*Lire.*		
Milano	Parma	1	Refined	1,883.7	14,985	560.09	$13.59	1,055,037	$203,622	
	Piacenza	1	Benzine	828.5	6,591	500.00	12.13	414,250	79,950	30
			Heavy oil	2.5	20	400.00	9.65	1,000	193	
Roma	Chieti	1	Refined	19.0	151	550.00	13.35	10,450	2,017	4
Total		3		2,733.7	21,747	541.66	13.14	1,480,737	285,782	34

Production of refined petroleum in Italy in 1897, by districts.

Mining district.	Province.	Number of works.	Kind of product.	Production.						Number of laborers.
				Quantity.		Value.				
				Metric tons.	Barrels of 42 gallons.	Per ton.	Per barrel.	Total.		
						Lire.		*Lire.*		
Carrara	Genova	1	Heavy oil	12	95	300.00	$7.00	3,600	$695	4
Milano	Milano	1	Light oil	1,390	11,057	559.90	13.58	778,297	150,211	10
	Parma	1	Benzine	395	3,142	502.20	12.17	198,150	38,242	6
	Piacenza	1	Heavy oil	583	4,638	170.90	4.15	99,720	19,246	24
Napoli	Napoli	1	Light oil	24	191	550.00	13.28	13,200	2,548	4
			Heavy oil	143	1,138	300.00	7.28	42,900	8,280	
Roma	Roma	1	Light oil	17	135	550.00	13.37	9,350	1,805	10
	Chieti	1	Heavy oil	35	278	192.20	5.07	7,300	1,409	
Torino	Alessandria	5	Light oil	29	231	550.00	13.28	15,950	3,078	32
	Torino		Heavy oil	764	6,078	300.00	7.28	229,200	44,236	
Total		12		3,392	26,983	412.05	10.00	1,397,667	269,750	90

Production of refined petroleum in Italy in 1898, by districts.

Mining district.	Province.	Number of works.	Kind of product.	Production.						Number of laborers.
				Quantity.		Value.				
				Metric tons.	Barrels of 42 gallons.	Per ton.	Per barrel.	Total.		
						Lire.		*Lire.*		
Carrara	Genova	1	Light	3	24	550.00	$13.27	1,650	$318	4
			Heavy	34	271	200.00	4.84	6,800	1,312	
Milano	Milano	2	Light	1,406	11,185	559.20	13.56	786,245	151,745	17
	Parma	1	Benzine	482	3,834	511.40	12.42	246,710	47,615	6
	Piacenza	1	Heavy	357	2,839	250.00	6.08	89,350	17,245	25
Napoli	Napoli	1	Light	24	191	550.00	13.34	13,200	2,548	4
			Heavy	143	1,138	300.00	7.27	42,900	8,280	
Roma	Roma	1	Light	13	103	550.00	13.39	7,150	1,380	10
	Chieti	1	Heavy	23	183	200.00	4.85	4,600	888	
Torino	Alessandria	3	Light	70	557	500.00	12.12	35,000	6,755	32
	Torino		Heavy	2,485	19,768	300.00	7.28	745,500	143,881	
Total		11		5,040	40,093	393.19	9.53	1,979,105	381,967	98

EXPORTS TO ITALY.

Quantity of petroleum exported from the United States to Italy from 1864 to 1898.

Year.	Metric tons.	Barrels.	Year.	Metric tons.	Barrels.
1864	1,214	9,657	1882	61,500	489,233
1865	8,398	66,734	1883	67,630	537,997
1866	12,362	98,340	1884	73,693	586,228
1867	18,551	147,573	1885	92,713	737,532
1868	35,396	281,575	1886	71,268	566,937
1869	29,526	234,879	1887	75,411	599,895
1870	38,354	305,106	1888	69,861	555,744
1871	42,791	340,402	1889	71,331	567,438
1872	41,555	330,570	1890	71,178	566,221
1873	34,401	273,660	1891	72,547	577,111
1874	43,881	349,073	1892	74,487	592,544
1875	45,199	359,558	1893	74,963	596,331
1876	43,793	348,373	1894	74,174	590,054
1877	36,795	292,004	1895	68,617	545,848
1878	60,330	479,925	1896	70,217	558,576
1879	58,560	465,845	1897	68,973	548,680
1880	57,571	457,977	1898	70,655	562,060
1881	59,571	473,887			

Quantity and value of refined petroleum exported from the United States to Italy, 1890 to 1899.

Year.	Illuminating.		Lubricating.	
	Gallons.		*Gallons.*	
1890	19,747,758	$1,642,830	510,622	$68,553
1891	20,955,728	1,495,511	591,996	74,031
1892	22,324,113	1,456,946	404,971	66,036
1893	22,815,279	1,344,582	788,805	101,939
1894	22,945,037	1,010,621	1,356,340	177,189
1895	28,017,572	1,188,156	1,381,587	177,624
1896	22,648,184	1,656,392	1,324,994	172,785
1897	24,525,066	1,731,203	1,550,688	243,547
1898	18,705,089	1,059,244	1,970,890	290,666
1899	19,750,201	948,518	1,921,123	259,126

GREAT BRITAIN.

While petroleum is not absolutely unknown in Great Britain, the production is insignificantly small. The largest production in the thirteen years from 1886 to 1898 was obtained in 1893—260 tons or 1,900 barrels. The exudations from the Carboniferous limestone long ago attracted the attention of geologists and chemists, and a crude oil was extracted from the shale by distillation. The first manufactory of this kind was established by James Young in Derbyshire in 1847. At the present time this mineral-oil industry is chiefly confined to Scotland. At one time it was a very profitable enterprise, but of late years, owing to the competition of the United States, it has had a somewhat precarious existence.

Crude oil is obtained in small quantities in North Staffordshire. There is also a small quantity produced near Alfreton, in Derbyshire, England.

The mineral statistics of the United Kingdom give the production and value of petroleum from 1886 to 1898 as follows:

Production and value of petroleum in Derbyshire, England, from 1886 to 1898.

Year.	Production.		Value. *a*	
	Tons (2,240 pounds.)	Barrels (42 gallons).	Pounds.	Dollars.
1886	43	314	129	627
1887	66	482	99	481
1888	35	256	....	....
1889	30	219	45	219
1890	35	256	52	253
1891	100	731	150	729
1892	218	1,594	409	1,988
1893	260	1,900	488	2,372
1894	49	358	92	448
1895	15	110	28	136
1896	12	88	29	141
1897	12	88	29	141
1898	6	44	14	68

a Value at wells, £1=$4.86.

THE SCOTCH SHALE OIL INDUSTRY.

The Scotch shale oil industry at present is confined to the vicinity of Midlothian and Linlithgow, in the vicinity of Edinburgh. At one time it appeared in immediate danger of extinction, but the introduction of improved methods of manufacture and greater economy have reduced the cost of production so that for several years its cost has been no greater than the cost of American crude delivered at the Scotch refineries.

Several of the companies engaged in the manufacture of oil from the shale report fair returns on their capital stock during 1899, while others were operated at a loss and compelled to pass their dividends. At the annual meeting of the Linlithgow company held at Edinburgh the present year, the chairman referred to the depressed condition of the trade and said that unless an improvement should take place in the value of refined products it was doubtful if the company could continue. During the past year every product, without exception, had been more than in the previous year, but the advance in wages and the increased price of fuel and other articles had swallowed up a considerable portion of the gains. He anticipated a fairly successful year, but said it was a matter for regret that the company was not provided with more modern retorts. This was owing to lack of means, but the position of the company had been such that the directors had

thought it undesirable to ask the shareholders for money for this purpose. He hoped, however, that if later on the directors were in a position to ask for this money the shareholders would not refuse to give it.

On the other hand, the Pumpherston Oil Company, Limited, of Glasgow, reported that the year's results were the most successful in the history of the company. A net profit of £65,869 was shown by the books, and after writing off several large sums for depreciation, the replacement of retorts, etc., a dividend of 9 per cent was declared on the preference shares, which was 3 per cent per annum in arrear for the year ending April 30, 1899, and a dividend of 20 per cent on the ordinary and preferred shares. The improvement in the result of the year's working was due to two causes—higher prices for their product and improved plant. The demand for their oil was increasing and a further advance in price was anticipated. The Broburn Oil Company, of Glasgow, likewise made a large profit during the year, and a dividend of 15 per cent was declared on the ordinary shares. The directors' report of Young's Paraffin Light and Mineral Oil Company, Limited, was a very favorable one and showed a credit of £52,540 to profit and loss account, after charging up £22,389 for maintenance of works and mines.

In the following table is given the quantity and value of oil shale produced in Great Britain during the years 1897 and 1898:

Quantity and value of oil shale produced in Great Britain in 1897 and 1898.

Country.	1897.		1898.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
England	10,568	£2,642	2,975	£744
Scotland	2,211,617	552,904	2,133,409	533,352
Wales	1,560	390	1,609	402
Total	2,223,745	555,936	2,137,993	534,498

A ton of bituminous shale yields very nearly an American barrel of petroleum distillate, and its cost is very close to the value of an American barrel of crude oil laid down in Scotland. The majority of the petroleum shale mines are located in Midlothian and Linlithgow, near Edinburgh, the Scottish capital. A hundred gallons of crude shale oil obtained by simple distillation of the bituminous rock yields about 30 gallons of fair illuminating oil, 16 gallons of heavy oil, 14 gallons of paraffin scale, 8 gallons of lighter oils, and 5 gallons of petroleum spirits, while the residue is tar and coke, suitable only for fuel purposes. Each ton of shale likewise yields about 50 pounds of sulphate of ammonia.

The quantity and value of oil shale produced in Great Britain from 1873 to 1898 are shown in the following table:

Production of oil shale in the United Kingdom from 1873 to 1898.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Tons.			*Tons.*	
1873......	524,095	£262,047	1886......	1,728,503	£435,963
1874......	362,747	181,373	1887......	1,411,378	355,085
1875......	437,774	218,887	1888......	2,076,469	519,074
1876......	603,538	301,769	1889......	2,014,860	503,715
1877......	801,701	400,850	1890......	2,212,250	608,369
1878......	788,704	394,352	1891......	2,361,119	707,177
1879......	783,748	391,824	1892......	2,089,937	522,484
1880......	837,805	418,902	1893......	1,956,520	489,130
1881......	958,255	479,127	1894......	1,986,385	496,596
1882......	1,030,915	310,685	1895......	2,246,865	561,716
1883......	1,167,943	299,676	1896......	2,419,525	604,881
1884......	1,518,871	386,780	1897......	2,223,745	555,936
1885......	1,770,413	447,302	1898......	2,137,993	534,498

It will be noted that there was a steady decline in the production from 1896 to 1898.

The oil-shale industry of Scotland is of no small importance, and the quantity worked has increased very considerably during the last twenty years. The mineral is obtained chiefly in Edinburghshire and Linlithgowshire from seams in the Calciferous sandstone at the base of the Carboniferous rocks.

A British engineering magazine, in commenting upon the improved condition of the Scotch mineral-oil industry during the year 1899, remarked as follows:

An industry which has been materially benefited—perhaps saved from extinction—by the general prosperity and the rise in prices of most products is the Scotch shale-oil manufacture. For years the distilling of oil from shale in Scotland has been carried on under difficulties. At one time it was a profitable business, but the strong competition and the low prices at which petroleum has been sold in Great Britain have for several years past taken away the surplus over expenses and forced the sale of oil at prices which could not pay. Notwithstanding the close economy exercised in manufacturing, the companies were forced to reduce their dividends and finally to pass them altogether, while several of them last year did not earn enough to cover their expenses. Early in the present year, however, the prices of American illuminating oil began to rise, and some time ago they reached a point which left a fair profit on shale oil. There has been also a corresponding rise in the price of paraffin, which is an important item with the shale distillers, and this has still further strengthened their position. As only a small part of the output is covered by yearly contracts, the manufacturing companies are getting nearly the full benefit of the rise, and this means much to them. The shale-oil industry is noted for the care with which it has been carried on, the close attention to details, and the readiness to adopt improvements—all signs of intelligent management.

IMPORTS.

The United Kingdom imported from the United States in 1899 166,194,455 gallons—nearly 4,000,000 barrels—of all grades and buys more petroleum and its products than any other country.

Quantity and value of petroleum oils imported into the United Kingdom from the United States, of all grades, in 1897, 1898, and 1899.

[Gallons.]

Month.	Quantity.		
	1897.	1898.	1899.
January	10, 970, 713	17, 490, 123	13, 339, 763
February	10, 540, 848	20, 144, 985	15, 972, 405
March	7, 696, 372	16, 196, 063	14, 393, 897
April	11, 028, 180	11, 060, 441	17, 467, 939
May	10, 822, 267	10, 475, 173	13, 261, 046
June	11, 261, 458	11, 330, 001	16, 226, 184
July	17, 226, 459	10, 113, 423	14, 303, 034
August	11, 495, 192	17, 010, 418	14, 340, 004
September	12, 326, 056	17, 916, 300	9, 580, 262
October	16, 016, 452	12, 779, 940	9, 683, 778
November	12, 447, 290	10, 529, 834	11, 438, 123
December	14, 531, 602	16, 514, 662	16, 188, 020
Total	146, 362, 889	171, 561, 363	166, 194, 455

Month.	Value.		
	1897.	1898.	1899.
January	£217, 680	£285, 139	£265, 979
February	222, 838	322, 717	304, 279
March	156, 560	248, 337	296, 443
April	206, 283	189, 266	351, 460
May	203, 387	193, 660	258, 566
June	219, 618	198, 679	313, 140
July	298, 754	191, 390	284, 034
August	215, 465	302, 321	276, 646
September	232, 348	312, 884	216, 332
October	289, 419	236, 727	223, 578
November	231, 329	208, 667	279, 789
December	269, 161	333, 999	367, 691
Total	2, 762, 842	3, 023, 786	3, 437, 937

Quantity and value of petroleum imported into the United Kingdom in 1897, 1898, and 1899, by countries.

[Return by board of customs.]

Country whence imported.	1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Russia	38,182,903	£526,994	46,012,011	£645,241	69,590,286	....
United States	146,362,889	2,762,842	171,561,363	3,023,786	166,194,455	£3,437,937
Other countries.....	1,119,584	45,435	1,676,165	64,605	4,137,940	....
Total..........	185,665,376	3,335,271	219,249,539	3,733,632	239,922,681	3,437,937

The following table gives the total importation of petroleum and its products into the United Kingdom from the United States and Russia for 1896, 1897, 1898, and 1899:

Total imports of petroleum (in barrels or their equivalent) into the United Kingdom in 1896, 1897, 1898, and 1899.

Port.	1896.		1897.	
	American.	Russian.	American.	Russian.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
London	1,335,840	522,773	1,422,263	412,610
Liverpool..............	663,109	258,527	684,121	368,462
Bristol	427,366	....	391,519	....
Hull	340,295	15,540	321,802	12,922
Clyde	58,292	....	51,144	50
Dublin	105,105	....	103,040	....
Other ports	65,089	50,437	115,198	....
Total...........	2,995,096	847,277	3,089,087	794,044
Grand total.....	3,842,373		3,883,131	

Total imports of petroleum (in barrels or their equivalent) into the United Kingdom in 1896, 1897, 1898, and 1899—Continued.

Port.	1898.		1899.	
	American.	Russian.	American.	Russian.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
London	1, 630, 687	611, 824	1, 356, 902	855, 787
Liverpool	887, 489	387, 519	897, 451	586, 315
Bristol	439, 129	....	362, 782	....
Hull	332, 862	....	364, 226	16, 500
Clyde	54, 740	....	280, 129 (Clyde, Dublin, and other ports)	....
Dublin	56, 887	....		
Other ports	65, 708	....		
Total	3, 467, 502	999, 343	3, 261, 490	1, 458, 602
Grand total	*a* 4, 466, 845		*b* 4, 720, 092	

a In addition to this quantity there were imported from America 145,368 barrels of naphtha and 128,557 barrels of residuum (chiefly described as "distilled"), of which 84,144 barrels were received at London, 26,067 barrels at Liverpool, and 18,346 barrels at Bristol.

b In addition to this quantity there were imported from America 155,335 barrels of naphtha and 107,680 barrels of residuum.

Imports of refined petroleum from America and Russia to Great Britain.

[Barrels.]

Year.	From America.	From Russia.	Total.
1883	1, 329, 004	502	1, 329, 506
1884	927, 919	17, 078	944, 997
1885	1, 367, 720	70, 149	1, 437, 869
1886	1, 363, 801	46, 814	1, 410, 615
1887	1, 444, 350	188, 461	1, 632, 811
1888	1, 286, 148	549, 126	1, 835, 274
1889	1, 355, 590	771, 227	2, 126, 817
1890	1, 357, 122	787, 529	2, 144, 651
1891	1, 647, 772	830, 863	2, 478, 635
1892	1, 711, 089	807, 600	2, 518, 689
1893	2, 209, 619	743, 094	2, 952, 713
1894	2, 736, 236	578, 115	3, 314, 351
1895	2, 730, 009	602, 900	3, 332, 909
1896	2, 992, 709	633, 971	3, 626, 680
1897	2, 755, 486	494, 278	3, 249, 764
1898	2, 843, 541	915, 354	3, 758, 895
1899	3, 261, 490	1, 458, 602	4, 720, 092

Quantity of petroleum oils exported from the United States to the United Kingdom from the year 1890 to 1899, as reported by Bureau of Statistics, Treasury Department.

[Gallons.]

Year ending June 30—	Crude.	Refined.		
		Naphthas.	Illuminating.	Lubricating.
1890		5, 603, 994	66, 393, 246	17, 035, 447
1891		5, 058, 325	81, 028, 529	18, 767, 573
1892		6, 813, 416	94, 901, 777	18, 779, 806
1893		8, 209, 526	180, 996, 321	17, 683, 132
1894		6, 834, 760	274, 555, 010	19, 668, 767
1895	3, 997, 013	7, 343, 355	279, 064, 424	21, 209, 497
1896		7, 236, 285	181, 883, 052	23, 436, 081
1897		7, 125, 371	185, 200, 507	21, 301, 290
1898	5, 060	7, 380, 140	179, 160, 587	25, 724, 836
1899	310	7, 584, 526	178, 796, 530	26, 353, 051

SUMATRA.

PRODUCTION.

The production of petroleum in Sumatra in 1899 was 24,187,530 gallons (equal to 861,610 barrels), as compared with 52,821,560 gallons in 1898, showing a decline of 54 per cent. This decline is due to the presence of large quantities of salt water, and the consequent falling off in the production of the wells of the Royal Dutch Company and others in the field. The salt water made its first appearance in 1898.

During 1899 there were a number of wells put down outside of the developed section, some of which gave favorable results; the distance from the refineries, however, was so great that they were not connected up by pipe lines. Most of the wells have heretofore been flowing wells, but during the latter part of the past year many of them stopped flowing, and there was considerable delay until power to lift the oil to the surface could be procured. As there is too much sand for the use of cups the oil can not be raised by ordinary pumps. It will require much new work and a large amount of outlay for hoisting appliances and pipe lines to restore the former production.

The wells are from 800 to 1,000 feet in depth and generally pass through soft material until the sand is reached. During the early part of 1897 nearly all the wells flowed from 200 to 600 barrels per day, but are now producing an insignificant amount.

This has been a source of disappointment to the Holland investors, after the flattering beginning that was experienced.

Corresponding with the decreased production of crude, there was a large falling off in the cases of refined products in 1899 as compared with 1898.

We are indebted to Mr. Adrian Stoop, of the Dordtsche Petroleum Maatschappij, for the following table, giving the production of refined petroleum in Sumatra from 1892 to 1899, inclusive:

Production of refined petroleum in Sumatra, 1892 to 1899.

Year.	Production.		
	Cases.	Liters.	Gallons.
1892	144,703	5,209,308	1,376,303
1893	401,370	14,449,320	3,817,149
1894	1,042,943	37,545,948	9,919,670
1895	1,334,249	48,032,964	12,690,347
1896	1,851,512	66,654,432	17,610,154
1897	4,564,987	164,339,532	43,418,635
1898	5,553,600	199,929,600	52,821,560
1899	2,543,050	91,549,800	24,187,530

1 liter=1.0567 United States quarts.
3.785 liters=1 United States gallon.
1 case=36 liters=9.51 gallons.
1 liter=61.02 cubic inches.
1 gallon=231 cubic inches.
1 quart=57.75 cubic inches.
To reduce liters to quarts, divide by 0.9465 or multiply by 1.0567.
To reduce liters to gallons, divide by 3.785 or multiply by 0.2642.
To reduce quarts to liters, multiply by 0.9465 or divide by 1.0567.
To reduce gallons to liters, multiply by 3.785 or divide by 0.2642.

In the following table are given statistics of the production of refined petroleum in Sumatra, by districts and months, in cases, 1898 and 1899:

Production of refined petroleum in Sumatra.

[Cases.]

Month.	Langkat.		Palembang.
	1898.	1899.	1899.
January	520,000	250,000	43,500
February	580,000	170,000	49,000
March	710,000	171,000	31,000
April	740,000	160,000	58,000
May	839,000	149,000	56,000
June	471,500	137,000	49,000
July	382,000	127,500	42,000
August	300,000	129,000	75,000
September	270,000	133,550	68,000
October	250,000	129,000	67,000
November	270,000	128,500	63,000
December	221,100	164,500	92,500
Total	5,553,600	1,849,050	694,000

JAVA.

Java, Sumatra, and a large part of Borneo belong to Holland and form a part of the Dutch East Indies. The statistics of the production of petroleum in 1899 were not available when this report went to press; enough, however, is known to show that the production increased slightly during the year.

One of the peculiarities of the petroleum found in Java is that a good part of it is rich in paraffin and therefore differs from that found so far on the adjoining islands. This is discussed further on. The following table shows the production of petroleum in Java in 1897 and 1898, and the indications are that 1899 will add about 2½ million gallons to the production of 1898:

Production of crude petroleum in Java in 1897 and 1898, by districts, in liters and gallons.

Districts.	1897.	1898.	1897.	1898.
Residency of Rembang:	*Liters.*	*Liters.*	*Gallons.*	*Gallons.*
Panolan	27, 595, 979	34, 473, 474	7, 290, 879	9, 107, 919
Tinawoen	19, 550, 504	23, 118, 014	5, 165, 259	6, 107, 797
Total	47, 146, 483	57, 591, 488	12, 456, 138	15, 215, 716
Residency of Samarang:				
Troeko	....	22, 680	....	5, 992
Residency of Soerabaya:				
Djabakotta	6, 270, 545	5, 250, 000	1, 656, 683	1, 387, 054
De Twaalf Dessa's	18, 393, 433	12, 477, 238	4, 859, 559	3, 296, 496
Lidah Koelon	14, 705, 675	10, 897, 653	3, 885, 251	2, 879, 169
Metatoe	....	6, 425, 000	....	1, 697, 490
Total	39, 369, 653	35, 049, 891	10, 401, 493	9, 260, 209
Grand total	86, 516, 136	92, 664, 059	22, 857, 631	24, 481, 917

To reduce liters to gallons divide by 3.785 or multiply by 0.2642.
To reduce gallons to liters multiply by 3.785 or divide by 0.2642.

The production of petroleum in Java for seven years past is shown in the following table in gallons:

Production of crude petroleum in Java from 1893 to 1899.

Year.	Gallons.	Year.	Gallons.
1893	16, 800, 000	1897	22, 857, 631
1894	7, 056, 000	1898	24, 481, 917
1895	12, 333, 468	1899	[a] 14, 298, 769
1896	21, 211, 203		

[a] Not complete.

The following statistics, given by the Dordtsche Petroleum Industry Maatschappij, Java, show their production of crude and refined petroleum from 1895 to 1899 in the districts of Soerabaya and Rembang:

Production of petroleum in Java from 1895 to 1899, by districts.

District.	1895.	1896.	1897.	1898.	1899.
Residency of Soerabaya:					
Crude ......gallons..	8,915,088	11,069,668	11,224,131	9,473,000	6,597,429
Refined ......cases..	525,004	604,418	627,966	542,845	601,217
Residency of Rembang:					
Crude ......gallons..	3,418,380	10,141,535	7,458,373	9,317,162	7,701,340
Refined ......cases..	222,904	638,916	791,431	947,493	1,041,563

At the close of 1899 this company had 71 producing wells in the residencies of Soerabaya and Rembang, an increase since 1898 of 18 wells, the number producing at the close of 1898 being 53.

From the yearbook for 1899, published by the Dordtsche Petroleum Industry Maatschappij, we extract the following information relative to their operations in Java. The production of the refined oil at the Panolan refinery is also given:

Production of refined petroleum in Java from 1896 to 1899.

[Cases. 1 case=9.51 gallons.]

Month.	1899.	1898.	1897.	1896.
January	129,169	113,656	106,185	86,146
February	106,175	96,179	103,785.5	89,443
March.........	123,938	125,995	123,305	103,276
April..........	114,403	122,817	114,394	93,101
May	153,178	115,680	117,863	100,587
June	149,018	126,365.5	127,281	97,374
July	153,741	138,532.5	144,767	95,337.5
August	148,077	124,222	119,222	97,844
September....	148,551	123,660.5	127,458	98,111.5
October	141,765	141,216.5	120,976	114,204
November	138,428	138,271	126,091.5	112,255
December	136,337	123,743	123,648	118,426.5
Total.....	1,642,780	1,490,338	1,454,976	1,206,105.5

Production of refined oil at Panolan.

[Cases.]

Month.	1899.	1898.	1897.	1896.
January	50,000	31,500	20,000	38,200
February	37,000	31,800	23,000	44,000
March	45,500	50,000	30,300	42,000
April	35,800	51,300	36,400	37,800
May	52,600	41,500	34,200	32,500
June	51,200	50,200	38,200	20,000
July	45,800	57,000	44,800	17,700
August	35,300	52,600	58,300	19,300
September	42,700	48,000	56,000	24,000
October	34,000	50,000	47,000	27,000
November	33,200	53,300	41,300	21,700
December	22,100	55,000	34,200	21,800
Total	485,200	572,200	463,700	346,000
Average per month	40,434	47,683	38,642	28,833

The report states further that—

The average selling price, which was 2.665 florins per box or case in 1898, was 3.427 florins in 1899. The increase of price, which had already commenced in the beginning of the year, continued the whole year, while the increase has remained at a very satisfactory height.

The difference in price between our petroleum and other brands in the Java market was maintained by us. We found, however, that the high prices of oil operated prejudicially on the sale, in that in some parts of Java, a partial return to the burning of vegetable oils was noticeable. This point, together with the fact of the heavy taxation of petroleum in India, deserves the very serious consideration of the Government.

The sale of the residue was much increased; the demand for asphalt was diminished, as it was also for illuminating oils. This last was connected with the suspension at the Solo works.

Conformably to the prospect held out in the preceding report, this year began with the delivery of paraffin candles, the production of which now goes on regularly. The production of paraffin is already much greater than necessary for the supply of candles for Java consumption, even if no imported candles were used. The sale ot candles was small in 1899, because this product first came into the market regularly in the beginning of 1900.

We are pleased to announce that our candles have a good name. In West Java they would like to see the shape changed, and this will be done as soon as possible. We have been fortunate enough to prepare paraffin which proves entirely satisfactory in the fact of being colorless and odorless. The year 1899 was taken up with the necessary preparatory experiments, so that we are first able to appear with this satisfactory product in the European market at the beginning of this year. Recently the first shipment was made from Java. The initial production is from 1,000 to 1,200 kilograms per day. We hope to increase this output considerably this year.

Our company was granted a concession for the production of petroleum in a district situated in the section of Djepon, residency of Rembang, which concession was called the mining concession "Djepon," and has an area of 25,357 bouws. The oil-producing grounds of Semanggi were, in the beginning of this year, connected with our establishment at Blora, so that its production will be given in the next yearly report.

Also the Madura oil will first form part of our product in 1900 on account of delayed laying of the foundation for pipe connections.

In our grounds in the residencies of Rembang and Soerabaya the borings were continued regularly on a large scale with variable success and we are pleased to announce that both in Soerabaya as well as in Rembang the quantity of salable oil in comparison with the preceding year increased so that in connection with our greater sale we have been able to increase our production. The production of Soerabaya, refinery Wonokromo, in 1899 amounted to 601,217 cases against 542,845 cases in 1898; for Rembang, refineries at Ngareng and Samarang, in 1899 was 1,041,563 cases against 947,493 cases in 1898, an increase for Soerabaya of 58,372 and for Rembang of 94,070 cases. The expenses of borings were as before entirely charged up to the account of working expenses.

In 1899 a contract was made with the petroleum exploration company "Tegal" for the transport, preparation, and sale of its petroleum in the spirit of a contract concluded the year before with the company Gaboes.

Toward the end of this year an agreement was made with the Madura Petroleum Exploration Company concerning the purchase of its rights of license and concession grounds on the Island of Madura, on which grounds this year our company will try hard to make the borings a success.

Better prices of oil and increased production were the very favorable results of our exploitation.

The following table shows the production of refined petroleum in Java from 1889 to 1899, inclusive, in cases, liters, and gallons.

Production of refined petroleum in Java, 1889 to 1899.

Year.	Production.		
	Cases.	Liters.	Gallons.
1889	8,000	288,000	76,082
1890	27,760	999,360	264,006
1891	79,179	2,850,444	753,016
1892	247,839	8,922,204	2,357,023
1893	276,062	9,938,232	2,625,432
1894	452,728	16,298,208	4,305,579
1895	779,239	28,052,604	7,410,797
1896	1,206,106	43,419,816	11,471,550
1897	1,454,976	52,379,136	13,838,609
1898	1,490,338	53,652,168	14,174,945
1899	1,642,780	59,140,080	15,624,856

PETROLEUM TRADE OF JAVA.

The following table, which is from a British consular report, gives some interesting statistics in regard to the petroleum trade of Java:

Imports of illuminating oils into Java.

[Cases.]

Illuminating oil.	1897.	1898.	1899.
American Devoes	1,565,294	879,477	1,084,090
American Tiger	....	446,956	171,500
Russian	582,014	365,284	764,887
Langkat	494,228	625,559	216,556
Total	2,641,536	2,317,276	2,237,033
Java oil, Wonokromo	621,620	546,101	596,656
Java, Blora	840,523	967,141	1,041,913
Total	4,103,679	3,830,518	3,875,602

The figures given show that there has been a slight increase in the consumption of petroleum during 1899. The importation from the United States shows a decrease, that is to say, that whilst the "Devoes" brand has been imported to the extent of 200,000 cases more, the "Tiger" brand shows a more than equivalent decrease.

The quantity of Russian oil shipped to Java during 1899 was about double that of the previous year, and whilst Langkat shows a large decrease Java oil shows a good increase.

Boring still continues in Java and the Isle of Madura, and it is reported that one company in the latter place has been successful in finding oil in paying quantities, and in the course of a month or so, when new tank lighters are ready, the raw product will be brought to their refinery near Sourabaya.

While cost of fuel generally is advancing it is interesting to note that a new source of supply will shortly be put on the market here by the agents of the Shell Transport and Trading Company, of London, in the shape of liquid fuel. This fuel is the residue left after refining the crude petroleum obtained from the above company's oil fields in Koetei, on the east coast of Borneo, and it has been proved from experience obtained from its use on board the steamers of the Royal Packet and other companies to be in many respects superior to coal.

It is maintained by the sellers that one ton of this liquid fuel is equivalent in steam-producing power to two tons of the best Japanese coal. It has possibly also a future before it as a fuel for industrial undertakings, railways, etc., some of which are already using the Dordtsche Petroleum Company's refuse.

A large tank has been constructed near Tanjong Priok (the harbor of Batavia) capable of containing about 4,000 tons of liquid fuel, and as the supply at Koetei is said to be practically inexhaustible, while the distance from the source of supply is comparatively short, it will be possible to replenish the stock at short intervals, so that the tank should prove sufficient to supply all the fuel required at this port in the event of owners of steamers trading here deciding to adopt its use.

BORNEO.

The developments on this island during the past two years have been particularly noticeable, and demonstrate the existence of large natural reservoirs of petroleum. All indications point to the fact that the three islands of Borneo, Sumatra, and Java are destined to furnish a large amount of fuel oil in future years. Owing to the scarcity of good coal in this great region, and the increasing scarcity of coal in England and elsewhere, indications for the future point to an enormous demand for this liquid fuel by sea-going steamers of all classes. The nearness of the petroleum districts to good harbors, which are on or near the paths of ocean travel, constitute other advantageous factors for their development. The illuminating products would find a large and growing market in Australia, India, China, and Japan. There are, however, several obstacles in the way of a very rapid development of this territory. The Dutch Government has many objectionable laws that hamper the investment of foreign capital and hinder the importation of skilled oil-well workers from other countries. The natives are not to be depended upon and the climate is hot and unhealthful. Civilization has only just reached a few of the larger seaport towns.

The geological formations of Sumatra, as shown by the reports, are similar to those of Roumania and Galicia, and include the older crystalline schists, eruptive rock, Devonian, Carboniferous, Cretaceous, and Tertiary formations.

A large amount of Dutch and English capital has been seeking investment in the petroleum districts of the Dutch East Indies. Of the corporations organized the Shell Transport and Trading Company is the largest, and has so far been the most successful.

A representative of the London Petroleum, Industrial, and Technical Review secured the following information in regard to the oil fields of Borneo from Mr. Samuel Samuels, one of the principal promoters and organizers of the Shell company:

The petroleum industry of Borneo is located in the Sultanate of Koetei, on the east coast of Borneo. The Sultanate is hereditary, and under the protection of the Dutch Government. It has an area of about 2,000 square miles. The population is very small, and consists principally of Dyaks in the interior and of Bougis in the lowlands. The country is well watered, some of the rivers are navigable to large vessels and all to small vessels.

Broadly speaking, the country is but a mass of jungle and swamp, even in the dry season. The seasons in Borneo are pretty definitely marked. There is a wet season and a dry season, as is usual in the tropics. The former extends from June to September, and the latter from September to the middle of May. Sometimes, in the dry season, there is not a drop of rain for months, except for a few light showers. In the rainy season it rains unfailingly every day.

The company has commenced working its petroleum property in four places, running in parallel lines, and has proved oil in each place. The difficulties of trans-

portation are almost insurmountable, and pipe lines have to be laid as the work goes on.

The chief difficulties encountered are in clearing the jungle land. The labor and cost involved in this are enormous, and the work in such a climate is very trying. Ninety per cent of our labor is occupied with this work, while the transportation of material is another heavy item. Altogether the company commenced 34 wells, and 25 of these are producing. They are mostly spouters, so that little pumping is, as yet, required. The production of some of these wells is over 300 tons per day. There has been as much as 700 tons per day. Nearly all the boilers and engines employed are run with gas, and gas is also used for driving the pumping engines for raising water.

It is absolutely necessary to have an enormous amount of storage accommodation, and to have it very widely distributed. It is also necessary to provide a large number of pumping stations to collect the oil. When complete there will be storage capacity for 200,000 tons of oil, and this, combined with the large fleet of steamers, will enable the company to handle unlimited quantities of oil.

A Dutch company was formed in order to comply with Dutch law, no foreigners being allowed to work. All the Dutch requirements were submitted to, as the undertaking was commercial and not political. Every employer has to pay income tax on salary and a tax on the living quarters, so much a year for each employee. This tax is fairly heavy and is raised by the Dutch Government.

At the present time the oil is refined locally, and for this purpose the company has erected a refinery which is capable of treating about 2,300 tons per day. It is not now working to the full extent, however, as the stills are not all completed. The production for 1899 was about 250,000 tons, but this is being increased.

The first real boring made on the property was only commenced in August, 1898. At that time there were only four bore masters, and the company has been steadily increasing the number since that time. It is hoped by the middle of 1900 to attain a production of about 20,000 tons of crude per week. Extra plants are now being put down. These are chiefly from England, and also a large quantity from America. The company has its own fitting shops on the property, in which are drilling machines, screwing machines up to 12 inches, steam hammers, etc., so that it is able to make the necessary repairs to its refineries, and also to its tank steamers, etc.

The Dutch Steamship Company, the Koniglich Pakevaart, are introducing liquid fuel on their vessels. The first steamer on which it was applied was the *Reinst*, and after working with liquid fuel for six months it is able to effect a saving of 25 per cent in working expenses. This same company has now adapted four other steamships for burning liquid fuel, and intends to convert the whole of its fleet to its use. Several of the local boats trading in the east have already been converted for the use of liquid fuel, and the Java railways are now using it, and are erecting storage accommodations in Java for the purposes of supply. Its use is extending in other directions also, and eventually there will not be a single country east of the Suez Canal not using liquid fuel.

Another report from the same source says:

In North Borneo, the Bombay-Burmah Trading Company is engaged in drilling, has obtained good results, and the company is now about to erect a refinery. The same company is also drilling on the island of Labuan, and has taken over the concession from Korszki. Petroleum is also being drilled for in Broenei and Sarawak with great success; nothing, however, is known on this point in the western division of the island.

The southern and eastern division of Borneo are marked by a plentiful supply of petroleum, especially in the districts of Koetei, Passir, Balangang, Tandjaeng, and Kaloewar.

There are three different companies working at Koetei: The London firm of S. Samuels & Co., the Koetei Exploration Company, and the Dordtsche Maatschappij.

Other petroleum companies in Java are:

The Linawoen Company, near Panolan. This company has a contract to supply its oil to the Dordtsche for the period of ten years, and possesses a pipe line of 19 kilometers to Blora. The company has had for the last four and one-half years a factory at Panolan for refining oil. This refinery produced in September, 1898, 48,000 cases of 36 liter.

In the neighborhood of Telawa (a station on the route to Semarang) there are at present two companies working—the Vost Indische Petroleum Maatschappij and the Netherlands-Indies Insulinde Petroleum Company. The former is drilling in the Demak division. The Insulinde is just now busy in erecting buildings and houses, while the machinery has already been rigged up.

The places where drilling is now carried on are Doemboeng, Doengsombre, Doengdjatti, Tambak Anoman, Redong Lélé, Nglandi, Tjermoe, and Gemolong.

The Rembang Petroleum Company has struck, in the Ngawie district, Blova division, a spouting well which has been named "Wilhelmina Well." The oil spouted 20 meters high, and the well was speedily closed up. The Java Petroleum Company drills in the Residency of Semarang, southeast of the capital. This company has purchased its concessions from the Chinese Klantoeng-Sodjomerld. Kendal division, and has an area of about 277 bomos.

The concession "Grobogan" extends 338 bomos, and situate in the Grobogan division, was merged in 1895 in the Nederlandsch-Indischi Petroleum Company, where borings have already been started.

Close to Moeara Djawa is the Sanga-Sanga River, where the borings are situated, at a distance of 8 paal (1 paal = 1½ English miles) from Mount Djawa. Eight spouting wells have up to the present been struck, and new borings are continually being made. According to the latest intelligence the syndicate struck, last month, a rich spouting well near Moeara Djawa. There has also been erected at Sanga-Sanga a petroleum storage tank for the superfluous oil.

A refinery is about to be erected near Balik Papan and the oil will be conducted by pipe line from Sanga-Sanga to the harbor of Balik Papan. The largest vessels in the world can not only anchor in this bay, but can be berthed at the quay as well. It is expected that the works will be completed about six months hence, so that a start can be made in the exportation of oil.

A narrow-gauge railway runs from Moeara Djawa to Sanga-Sanga. The syndicate possesses also three small steam launches which can navigate the Mahakan River. Here launches and engines are supplied with coal obtained from their own property in Borneo.

A further exploration of the island Miang along the Koetei coast is to be made, the land, it is believed, being very rich in oil. A private steamer is shortly expected from Singapore, to keep up a regular communication between this island and Samarinda. The capital of the Koetei Exploration Company amounts to 300,000 guilders. Mr. Stoop has for the last two years been engaged in drilling for oil, but hitherto without success.

The total imports of light oil into the Dutch Indies have been as follows:

Imports of petroleum into Dutch East Indies.

Year.	American.	Russian.	Total.
	Gallons.	*Gallons.*	*Cases.*
1876	3,677,460		
1886	21,107,280		
1890	18,420,126	12,400,000	3,082,012
1891	10,818,880	13,770,000	2,458,888
1892	11,561,560	16,023,660	2,758,522
1893	12,162,200	25,818,730	3,798,093
1894	26,022,200	6,839,570	3,286,177
1895	17,420,000	14,306,460	3,172,646

Ten gallons are equal to 1 unit=1 case.

The total consumption of light oil in Java and Madoera amounted in 1889 to 2,500,000 units and in 1896 to 3,600,000 units.

Java increased her consumption of Russian refined oil from 1,362,250 gallons in 1897 to 5,198,840 gallons in 1898. In 1896 her imports of Russian oil amounted to 9,749,700 gallons. American exports to Samarang, the principal port of Java, have, for the present year, reached 1,000,000 gallons, whereas in the previous year there were none.

The exportation of petroleum from the Dutch East Indies is extensive and reaches all parts of Asia and as far as Australia. Borneo and Sumatra are richest in the production of petroleum; then comes Java. The boring for crude oil reaches from 40 to 250 meters in depth. The usual percentage of refined oil secured is from 35 to 50 per cent, and in some cases 65 to 75 per cent.

The imports and exports of petroleum from the Dutch East Indies are given in the following table:

Imports and exports of petroleum in the Dutch East Indies, 1890 to 1898.

Year.	Imports.		Exports.	
	Liters.	Barrels.	Liters.	Barrels.
1890	113,582,000	714,487	56,000	352
1891	110,128,000	692,759	46,000	289
1892	119,313,000	750,538	3,912,000	24,609
1893	160,380,000	1,008,869	11,037,000	69,428
1894	119,299,000	750,449	26,588,000	167,252
1895	102,596,000	645,379	36,330,000	228,533
1896	92,780,000	583,632	48,713,000	306,429
1897	101,949,000	641,310	163,529,000	1,028,678
1898	81,469,000	512,480	161,179,000	1,013,896

Partial returns for the exports of 1899 show a very great falling off owing to failure of wells in Sumatra.

Quantity and value of refined petroleum imported into the Dutch East Indies from the United States, 1890 to 1899.

Year.	Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*	
1890	18,420,126	$1,754,827		
1891	21,633,290	2,052,937		
1892	17,017,200	1,302,676		
1893	15,560,640	1,106,523		
1894	26,316,369	1,637,149		
1895	15,155,540	1,068,715		
1896	16,947,830	1,427,770		
1897	24,989,000	1,851,887		
1898	12,534,930	809,083		
1899	15,371,400	1,189,329	60,909	$11,972

PHILIPPINE ISLANDS.

For several years petroleum has been known to exist on a number of islands of this group. It has been found on the islands of Cebu, Leyte, Negros, Bohol, the west coast of Zebu, the western end of Panay, and the southern section of Luzon.

Mr. George F. Becker, of the United States Geological Survey, who visited these islands, reports as follows:

In the island of Zebu petroleum has been found associated with coal at Toledo, on the west coast, where a concession has been granted. It is also reported from Asturias, to the northwest of Toledo on the same coast, and from Algeria, to the south. Natural gas is said to exist in the Zebu coal fields. On Panay, too, oil is reported at Janiuay, in the province of Iloilo, and gas is reported from the same island. Petroleum highly charged with paraffin is also found on Leyte at a point about 4 miles from Villaba, a town on the west coast.

A special correspondent of the Oil, Paint, and Drug Review reports as follows:

For a great many years the cost of illuminating oils to the natives of the Philippine Islands has been excessive.

Most of the oils used in the little lamps of the Philippine family is shipped in from Russia, and as it is sold out in small quantities in nearly all instances the price per gallon is about six times that in America. Yet this is a country in which the people can afford to buy illuminating oils only under strain.

The natives work on the plantations or about the homes of the richer classes for a small pittance, and are compelled to purchase such articles of household necessity as illuminating oil at five or six times the cost of the same oil in the United States.

When the oils are first landed on the wharves at the seaport cities or towns of the islands, the selling cost per 60-pound case is not more than double that of the American price. But it becomes necessary to expend considerable money in getting the oil distributed among the centers of the different islands. The wastage is very heavy, as the excessively hot climate tends to make the oil ooze through the tins into the wood of the cases and then drip. Many of the cases are caused to leak by the heavy rolling of the sea while on board ship, and considerable waste of oil results from this cause alone. Then the cases intended for packing for the interior must be arranged to suit the conditions of rough traffic on bullcarts without springs, on drag sleds, on the backs of pack animals, and at times carried by natives on a pole swung between the shoulders. All this adds to the cost of the oil, and this, combined with the frequent losses due to raids of ladrones and bandits on trains of merchandise, make it necessary for the dealers in oils to charge very high prices in order that they may make a profit on their business. The fact that the illuminating oils of the islands are so expensive makes any means of obtaining oils from the oil wells of the islands very valuable.

The oil wells exist in the southern section of Luzon, the western end of Panay, the interior of Negros, and they are found in various portions of Gimeras, Mindanao, and Cebu. The writer has seen the natives working the oil wells in several parts of the islands of the Philippine Archipelago, and in nearly every instance the product appeared to be worth the handling, even with the crude devices used by the natives. In recent years the Filipinos have done away with the personal handling of the oil to a great extent by using the pipe and other modes of conveying. They cause the oils to run down grade for long distances, thus saving the necessity of hauling the oil. The common bamboo material is used for the pipes and for many parts of the apparatus employed. The bamboo is cut from the forests of this wood and permitted to lie on the ground in the sun until it is seasoned. When thoroughly dry the wood is irony, firm, and yet elastic enough to answer all purposes without cracking or breaking.

The partitions of the bamboo are cut out, thus leaving the pipe passage clear. The next process consists in jointing the pipes, whose lengths average about 40 feet, so that these unions are made every 40 feet or more. Two pieces of bamboo are selected of the same diameter, and a shell piece, also bamboo, but smaller in diameter, is slipped in and held in place by the use of wood pins and a little of the gummy materials collected from the soft-wood trees of the forest. Then an outer sleeve is slipped over the ends of both pieces. This outer piece is thin stock and is wound at the ends with split bamboo. The ends are previously filled in with the glutinous matter, so that a very tight joint results, which will last in the service for two or three years before it begins to leak and to require renewing. The wood portion lasts indefinitely, for this bamboo is very tough and durable.

The plan employed for making an elbow in the pipe system consists in selecting a good and regular piece of the bamboo of the proper diameter to correspond with the pipes to be joined, and then V-shaped segment pieces are cut from one side of the bamboo. When closed the elbow assumes the proper shape, and then comes the process of stopping the places where the V-shaped pieces were joined. This is done by the use of the sappy stuffs secured from the trees of the forest. First some of the hemp of the islands is daubed with the tarry substances, and then the crevices are packed with this hemp, making the connections tight. Above this is wound a lot of the gummed hemp, which protects the elbow from injury. These elbows are remarkably strong, some of them having been constantly in use carrying oil for a long time without showing any indications of leakage or wear.

The method the natives have for elevating the oils from the wells to a common level so as to cause the liquid to move down the slope to the piping systems is as follows: First the proper location is found for the working of the oil wells in the

mountainous sections, and after driving a hole to the proper depth a bamboo pipe is sunk into it. Usually the bamboo of largest diameter serves for this, but in some places other hard woods hollowed out are used for this purpose. Then a mouthpiece or spout is put into the pump stock. Then the valve and rod must be constructed, and this is quite an ingenious piece of work. A round piece of wood is made to fit the interior of the pump, and this is hollowed out in sections, so that spokes remain to keep the valve intact, while at the same time the oil can be carried above at each stroke. Then some little flaps are secured in position on the top of this piece to act as valves. These flaps are of caribou hide, a material which is as tough as leather and possesses about the same qualification. In some cases the native oil pumpers use the pump on the suction order and again as a force pump. The liquids as pumped are deposited into the funnel of the tube which leads to the main lines of bamboo piping.

Interior connections consist in fitting the smaller end of one pipe into the larger end of another. This requires the pipes to be of the proper proportions, and the fit to be snug. Otherwise there will be constant trouble with leakage. The native bamboo-pipe fitters devote considerable time to the selection of the pipes thus to be joined, and they frequently wind the end of the inner pipe so as to get it to the proper size for a union with the other.

The pumping of the oil to the proper elevation is done by four natives at the brakes of the pumps in relays of two, who relieve one another at intervals, and there are as many pumps in service as the size of the operations warrant. In order to control the flow of the oils to the reservoirs, the natives use check or butterfly valves in the pipe lines near the pumps. It is all woodwork. The portion in which the valve is fitted is of larger size to accommodate the turning valve which is merely a disk of hard wood fitted to a stem, and the flow of the oil is regulated by turning this stem by hand.

The process of treating or refining the oils by the natives is ingenious and interesting, although crude. It consists in filtering them by the use of halves of bamboo poles or sticks arranged with one-half piece overlapping the other and arranged in parallel a distance equal to the full length of the sticks. The oil is poured over these beds of bamboo and is permitted to drip into the earth tank. This tank is made of a combination of sandstone and a sort of a cement material, through which the oil filters. By the time the oils have been treated in these various devices they become clear, and as they are naturally white in color and free from foreign deposits, the resulting oil is nice in appearance and suitable for illuminating purposes.

There are no drainpipes or in fact pipes of any description in the markets of the Philippines, and the only way that persons can secure pipes of any sort is to make special bids for them in America and other countries and await their arrival. A number of enterprising discharged soldiers and others have taken steps to introduce pipes into this country for service in drainage systems, for carrying spring waters to the cities and towns from the mountains, and for numerous other purposes, but as yet they have not reached the markets in Manila and Iloilo. Therefore the oil men of the hills do not depend upon the markets to furnish them with the piping for carrying the oils to the distributing centers, but use the bamboo entirely. The country is overrun with forests of this wood and the cost for labor for handling the same is very cheap, being only about 20 cents per day of American money.

The employment of the long lines of bamboo pipes which the natives are putting in is the direct means of the saving of a great deal of waste. It was formerly an impossibility to transport any considerable quantity of the oil to the desired points, owing to the lack of transportation facilities, but with lines of oil pipes available it is possible to keep up a constant flow of the oil day and night. Therefore the supply of oil shipped to the markets is not limited by lack of transportation. In transporting by cart or carrier the wastage was always very great, whereas by the pipe-line system

the wastes occur only at the joints, and if the natives are kept at these joints constantly this leakage is prevented to a great extent. As natives can be hired for 10 to 15 cents (American) per day, to attend to pipe joints, and as a native can readily attend to 4 miles of piping, it does not require much labor or expense to keep up the pipes. Besides acting as repairers to the joints, these natives are guards to the lines and are really patrols, for they are always on the move. They help to keep off the guerrillas, who, if they can not rob, will burn and loot, and, who prior to American occupation, would think nothing of setting fire to an oil-pipe line for the sake of watching the affair burn. But the American garrisons are so freely distributed through all of the islands at present that the freebooters have no opportunity to commit depredations as of old, and, so far as the writer has been able to ascertain, there have been no recent interferences with the pipe lines.

The millions of people of the islands who formerly managed to get along without proper lights and other comforts of life are now learning how to maintain the proper lighting for their previously darkened homes. The demand for lamps and for oils is vastly increasing, and the time is near when the illuminating-oil industry of the islands will be of great importance.

From the foregoing reports, as well as the general geological similarity and position of this group of islands to those that are now producing petroleum, lying as it does between the Dutch East India developments on the islands to the south and Formosa on the north, it would seem to indicate a probability that the Philippine Islands will some time in the future produce large quantities of petroleum.

EXPORTS OF REFINED PETROLEUM TO THE PHILIPPINE ISLANDS.

Most of the refined oils used in the Philippines comes from Russia and the Dutch East Indies.

From the United States 74,000 cases were imported in 1897. In 1898 there were only 30,000 cases imported, although a good part of that imported in 1897 was consumed in 1898. The high price of illuminating oils and the extreme poverty of the natives, together with the substitution of native vegetable oils, has operated against large consumption heretofore.

There were only 153 gallons of lubricating oil, valued at $46, exported from the United States to the Philippine Islands for the year ending June 30, 1899.

JAPAN.

The petroleum industry of Japan is rapidly assuming large proportions. Considerable foreign capital has been invested during the past year, and the work of drilling new wells and exploring new territory has been actively pursued. The number of refineries has been increased, and an extensive pipe-line system has been projected, but notwithstanding all this activity the production has not increased to any extent, and Japan depends upon other countries for nearly 90 per cent of her supply of illuminating oil. While making great progress, the industry has not yet fulfilled the expectations of those enthusiasts who predicted that it would eventually put a stop to the consumption of foreign oil.

The existence of petroleum in Japan has been known for centuries. The first refinery was built at Nagnoka in 1869. In 1876 the Government undertook a geological survey to ascertain the mineral resources of the country, and especially that of petroleum, and Dr. B. S. Lyman, of Philadelphia, was appointed chief geologist. After three years' work Dr. Lyman made a report on the oil fields. Soon after several large companies were formed, and the development of the Japan petroleum fields was started on an extensive scale. The Japan Oil Company was organized in Amaze, Echigo, in 1886, with a capital of 500,000 yen, or $250,000. This company immediately discontinued the old-fashioned ways of sinking oil wells or shafts by hand and adopted American methods. Two expert drillers from the United States were employed, and modern machinery introduced. The company now embraces in its divisions surveying, mining, and producing, transportation by pipe lines, with pump stations, refining and sales departments, etc. It also owns a large iron-working establishment and is engaged in making its own tools and building its own machinery.

In a recent report on the development of the Japanese petroleum industry Mr. S. Takaneo, of Tokyo, is authority for the following statement, which appeared in the London Petroleum Review:

> The Japan Oil Company is the first and the largest organization for this business ever started in Japan, and it has been carrying on its business successfully from the start. Amaze, where the company is located, is one of the most productive oil fields in Japan and is immediately on the shore of Japan Sea. The wells are put down in the sea, which is from 15 to 20 feet deep at this place and is filled in by stones and dirt. The derrick is put up on the top, and a drive pipe is used until the rock is reached. One such well from its beginning to the end cost the company at least $5,000, besides the foundation work in the sea, as all machinery, pipe, riggings, etc., had to be imported from the United States. There are now several hundred derricks standing close to each other on the sea, as well as on the seacoast of Amaze.
>
> New wells were started at different places, among which the discovery of Nagnoka oil fields, about 40 miles east of Amaze, Echigo province, was the most important.
>
> Instead of procuring the American tools for drilling, old "shafting" method was employed for putting down wells, together with so-called "kazusabori," or artesian-well method. The experiments were satisfactory. In 1893 one of the largest wells was struck at a depth of 540 feet, in Katsubo, Nagnoka, and the force of the oil flowing was so strong and sudden that in a few moments the well was filled with fluid to the top.
>
> The Nagnoka oil field became the head of the oil producing district in Japan, and maintains its record at the present time. Later, in 1894, the Nagnoka people sent for drilling tools and machinery to the United States, and the writer counted, a few years ago, more than 300 derricks crowded together in a small valley of this oil field, besides a couple of thousand wells sunk by shafting and artesian methods.
>
> In 1894 Nagnoka and Zawo pipe-line companies began 2-inch lines a distance of about 5 and 7 miles respectively. It was surprising to notice that the daily production of petroleum in this oil field increased from a hundred to a couple of thousand barrels in three years and the refineries increased from 2 to 30 during that period.

A new field was discovered the past year in the territory lying between the Amaze and Miyagowa districts near the seacoast. The

Japan Oil Company drilled the first well in that locality in 1894, but it proved very small, not making more than a barrel a day. In January, 1899, a well was drilled by the Nagnoka Oil Company, which at 760 feet started to flow at a 300-barrel rate. This created great excitement, and a number of other companies entered the new field. The crude from this section is of 33° gravity, Baumé, and contains no paraffin.

The Niitsu district has furnished many good wells in the past year. The oil has a peculiar odor, like camphor, and is said to be very valuable in the manufacture of high-test illuminating oil, as well as a light grade of lubricating oil.

As a result of this increased production new refining and transporting companies have been established. According to Mr. Takaneo:

The Japan Oil Company, with an increasing supply from its own wells, has found it necessary to erect another refinery (No. 2), at Kashiwaki, Echigo province, and the headquarters have been removed to that place. One of the new pipe lines was laid by this company.

Fifty tank cars have been made by the Ogura Company of Tokyo. They are for use in transporting oil from Echigo to Tokyo. This is the first experience in that line of manufacture in Japan.

The use of tar or heavy residuum for locomotives, boilers, steamboats, and manufacturing plants is another important departure resulting from the sudden development of the oil industry. Several successful experiments in this line have been made. Its feature of economy, to say nothing of convenience, will be best understood when the cost of coal, which is about $20 per ton for the best grades, is considered. The supply of fuel oil has been increased by the importation of Borneo and Oceanic crude. The latter oil is not only going to compete with the domestic production, but will prove a formidable rival for both the American and Russian products in the future.

The Japan Oil Company has increased its capital to 600,000 yen, or $300,000. In its semiannual report for the first months of the year this company declared a dividend of 40 per cent, including the earnings of the iron works in connection. Another company in the Nagnoka district paid 35 per cent earnings, while the lowest dividend, that of the Nagnoka Pipe Line Company, was 20 per cent. Thus it will be seen that the petroleum business of Japan, now in its infancy, is one of the most profitable in the country, and promises much greater returns when better facilities and larger works have been established. The demand of the present is for simpler drilling methods and refining processes which, owing to the peculiarities of the oil and oil-bearing formations, will require a careful study rather than that of either Russian or American methods.

Mr. E. Crowe, of the British foreign office, has furnished the following facts in regard to the Japanese petroleum industry to his Government:

In 1613 a man called Magara Nihei discovered oil at Karameki, near Niitsu, where a fire well is to be seen. Everyone agrees in giving this as the starting point of the oil industry.

For about two hundred years nothing important was done save a little hand boring here and there.

Between 1860 and 1870, however, a man named Noguchi, who had possessed great wealth and had lost it all, began digging and struck oil at Amaze.

The first refinery was started in 1869 at Nagnoka by Nakajima Sangoro and Wakizaka Hachigoro.

Oil was produced at Shiwodani (Niitsu) in 1874, and in 1876 Dr. Lyman, an American in the employment of the Japanese Government, surveyed the province and reported favorably on its oil-producing capabilities.

This gave an impetus to the industry and led to the boring of many wells, but it was not until 1886 that a large company—the Nippon Sekiyu Kwaisha—was established and began working at Amaze. The next year the Hokuetsu Kwaisha was started at Urase. Since then many companies have come and gone, and many changes, both in boring and refining, have been brought about by the introduction of steam machinery, iron pipes, and other novel appliances.

The quality and cost of the oil in the different districts varies considerably, as will be seen by the following table. The places are arranged according to degrees of excellence. The crude oil is sold per koku; the refined per box of 2 "to:" (The liquid koku equals 39.033 gallons; the "to" equals 4 gallons.)

Cost of crude and refined oil in Japan.

Name of oil.	Color.	Smell.	Cost of crude oil per koku.	Cost of refined oil per "to."
			Yen.	*Yen.*
Amaze	Red	Slight	5.80	2.20
Miyagawa, best	do	do	5	2.5
Miyagawa, poor	Brown	Strong	3	1.80
Urase-Hire	Black	do	2	1.25 to 1.80
Niitsu Koguchi	Green	Very strong	1.20	1.45
Shiwodani	do	do	1.5	1.35

	Yen.
American oil costs, per box	2.15
Russian oil costs, per box	2.8
Sumatran oil costs, per box	2.5

Mura costs about 2 yen, and what is called kikaiyu, a very refined product, brings 16 yen per koku.

The sulphuric acid which is used in treating the oil during the process of refining was formerly all brought from Osaka and Yamaguchi, but since last year a company called the Niigata Ryusan Kwaisha has started a factory on the spot and threatens to monopolize the trade.

Soda comes from many places, but is chiefly supplied by the Alkali Kwaisha at Kawaguchi and the Nippon Seimi at Shimonoseki.

Of the machinery used at the wells and refineries about 25 per cent is American, the rest being chiefly made at Tokyo, though the Nippon Sekiyu Kwaisha, who also own iron works at Niigata, turn out a small proportion.

Taking the province as a whole, there are from 8,000 to 10,000 men and women who get their living from this industry, the latter being chiefly employed in Kazusabori and in carrying the oil. The wages vary from 24 to 40 sen per day for ordinary workmen. Engineers and others get from 80 to 250 yen per month, some of them sharing in the profits.

As will have been seen, there are a great number of concerns, but very few of them are really prosperous. At present the most flourishing is undoubtedly the Koshi Hoden. It has a capital of 300,000 yen and pays 70 per cent per annum. It owned at first only 4,000 tsubo (1 tsubo=3.9 square yards) of land, which has been increased

to 15,000 tsubo, and next year with enlarged capital it means to start a refinery of its own.

The Nippon Sekiyu Kwaisha is one of the oldest and certainly the largest establishment. It has wells and refineries wherever oil is produced, and with a capital of 600,000 yen pays 15 per cent.

The Nagnoka Tekkau, with 15,000 yen capital, pays dividends of 40 per cent.

Of the other companies some pay a small dividend and others none at all, but it appears to be a business in which the most startling changes can be brought about in the space of a few months.

The total amount of oil shipped from Niigata last year was 500,000 boxes, but it is doubtful whether this year's total will be as much. The shipments were chiefly made to Kobe, Osaka, Tokyo, Hokkaido, Kaga, and Echizen, for further distribution all over the country, but the amount exported was very small, consisting of 5,900 boxes for Jinsen and 1,750 for Genzan.

PIPE LINES AND PRODUCTION.

There are about 40 miles of pipe line in the Japanese oil fields, which convey the oil to the refineries and various shipping points. It is difficult to get at the exact production, but it is estimated that up to 1898 it had probably not exceeded 12,000,000 gallons, or, in round numbers, 300,000 barrels in any year. In Echigo alone there are over thirty petroleum companies, with an aggregate capital of 12,000,000 yen, or about $6,000,000. A new pipe line is about to be constructed from Echigo to Tokyo, which will be the greatest feat yet undertaken in connection with the Japanese oil industry. The promoters of the enterprise have selected Mr. Miyagi, a graduate of the engineering college of Tokyo Imperial University, to act as advisory engineer for the preliminary survey. Hitherto the transportation of oil to Tokyo has been by rail, and the charges are quite heavy. The distance from Echigo to Tokyo is 230 miles.

REPORT OF MR. NAKASHIMA.

Through the courtesy of Mr. K. Nakashima, of Tokyo, Japan, we are enabled to give the following information regarding the petroleum industry in Japan in 1899. We regret to say that, owing to ill health, Mr. Nakashima has retired from official work connected with the geological survey of Japan, which position he has held for more than seventeen years. For many years Mr. Nakashima has contributed a statement on the petroleum industry of his country, and for most of the statistics given in our report we are indebted to him. He writes as follows:

In 1899 the production has undoubtedly increased in a remarkable degree, owing to the successful development in the newly discovered oil field of Kamada and Nagamine, in the Kariha district of Echigo, and as a result the total production of Echigo alone in this year is supposed to have been at least 800,000 koku. (1 koku = 39.7 English gallons=1.1 United States barrels.) Such sudden progress in the history of the oil industry has given fresh impulse to many adventurers, and many companies have

sprung up since the latter part of last year for the exploration of both old and new fields, and, judging from present indications, a production of 1,000,000 koku in the oil fields of Echigo is possibly not a matter of difficulty in the near future.

The newly discovered oil field of Nagamine and Kamada is situated in the hill ranges running along the coast of the Japan Sea. Here and there places yielding natural gas were observed, and more than ten years ago some shafts were sunk to the depth of 50 to 70 ken (298 to 418 feet, as a ken is 5.965 feet) to take out the oil, and though oil was seen deeper working was obstructed by too much water and wells were abandoned. It was in the early part of 1897 that, in boring a well, the Japan Oil Company struck, at a depth of 90 ken (537 feet), a spot where strong gas burst out, accompanied by the gushing up of oil of over 100 koku. Soon wells were successively sunk in the surrounding neighborhood, mostly proving fruitful, and at present (April, 1900) out of 16 productive wells a daily yield of 1,600 koku is obtained. The depth of the wells varies from 100 to 150 ken (596 to 895 feet). The crude oil obtained shows average specific gravity of 0.909 and an average of 24.8° Baumé.

By the prosperity of the localities in the western hill range (Nagamine, Kamada, Miyagawa, and Ushinodani) those of the eastern range (Urase, Katsubozawa, Tenbakizawa, Katsurazawa, near Nagnoka) became less noted, the yield of individual wells here being smaller than in the western range, but the condition of the industry in the eastern district is by no means discouraging. In the western district a daily yield of 70 to 100 koku is common where first struck, while in the eastern district it can not reach over 20 or 30 koku. The production of 1899 in this eastern field has been ascertained to be 255,510 koku, the most recent monthly yield (March, 1900) being nearly 22,000 koku. The depth of the productive wells varies, but is usually little above or below 100 ken (596 feet).

The third important field in production is that of Niitsu, but, its oil being dense and black, its much lower value hinders much the industrial development in this quarter. The monthly yield at present (March, 1900) is roughly 12,000 koku. The productive wells are generally shallow in this field, ranging from 60 to 125 ken (358 to 746 feet).

The production of crude petroleum in Japan from 1875 to 1898, inclusive, is shown in the following table. The production and value of refined petroleum for the same years are given, except for 1896, 1897, and 1898.

Production of petroleum in Japan, 1875 to 1898, inclusive.

Year.	Production.				Value received for crude and refined sold.	
	Crude.		Refined. *a*			
	Koku. *b*	Gallons.	Koku. *b*	Gallons.	Yen. *c*	Dollars.
1875....	4,830	191,751	....	....	....	....
1876....	8,155	323,753	....	....	....	....
1877....	10,114	401,526	....	....	....	....
1878....	18,920	751,124	....	....	....	....
1879....	24,816	985,195	....	....	....	....
1880....	26,974	1,070,868	....	....	....	....
1881....	17,721	703,524	....	....	....	....
1882....	16,450	653,065	....	....	....	....
1883....	21,659	859,862	....	....	....	....
1884....	29,541	1,172,778	6,215	246,735	107,964	92,633
1885....	30,931	1,227,961	7,326	290,842	98,496	84,510
1886....	40,113	1,592,486	13,487	535,434	136,911	110,898
1887....	30,304	1,203,069	8,830	350,551	126,298	99,018
1888....	39,605	1,572,318	4,511	179,087	138,602	104,367
1889....	55,871	2,218,079	7,097	281,751	250,977	184,217
1890....	54,399	2,159,640	11,180	443,846	221,478	166,551
1891....	55,983	2,222,525	13,012	516,576	207,029	172,041
1892....	72,893	2,893,852	13,431	533,211	207,245	154,398
1893....	83,644	3,320,667	10,941	434,358	178,290	117,850
1894....	138,077	5,481,657	13,980	555,006	245,697	136,608
1895....	149,497	5,935,031	17,241	684,468	351,607	172,639
1896....	208,500	8,277,450	(*d*)	(*d*)	(*d*)	(*d*)
1897....	231,221	9,179,474	(*d*)	(*d*)	468,546	239,427
1898....	280,764	11,146,331	(*d*)	(*d*)	(*d*)	(*d*)

a This production of refined oil is not the whole amount of refined oil made in Japan, but is only that portion which is refined by those who produce crude oil and refine it themselves. Most of the crude oil goes into the hands of others, by whom it is refined, and as yet there is no means of ascertaining this quantity.

b 1 koku = 39.7 English gallons = 1.1 United States barrels.

c Value of yen on January 1, 1885, in United States money, 85.8 cents; 1886, 81 cents; 1887, 78.4 cents; 1888, 75.3 cents; 1889, 73.4 cents; 1890, 75.2 cents; 1891, 83.1 cents; 1892, 74.5 cents, 1893, 66.1 cents; 1894, 55.6 cents; 1895, 49.1 cents; 1896, 52.9 cents; 1897, 51.1 cents; 1898, 49.8 cents; 1899, 49.8 cents; 1900, 49.8 cents.

d Not ascertained.

From reports the production for 1899 has been estimated at 32,000,000 gallons, owing to newly discovered fields.

The production of crude petroleum in Japan, as ascertained by the mining bureau, is given, by provinces, in the following table:

Production of crude petroleum in Japan in 1880, 1884, 1885, and 1892 to 1898, by provinces.

Province.	1880.		1884.		1885.	
	Koku.	Gallons.	Koku.	Gallons.	Koku.	Gallons.
Echigo	22,607	897,498	24,482	971,935	25,923	1,029,143
Totoumi...	3,875	153,838	3,784	150,225	3,630	144,111
Ugo.......	229	9,091	771	30,609	805	31,959
Shinano ...	263	10,441	481	19,096	425	16,873
Ishikari ...	....	....	23	913	148	5,875
Total..	26,974	1,070,868	29,541	1,172,778	30,931	1,227,961

Province.	1892.		1893.		1894.	
	Koku.	Gallons.	Koku.	Gallons.	Koku.	Gallons.
Echigo	69,042	2,740,968	80,259	3,186,282	134,826	5,352,592
Totoumi...	2,832	112,430	2,507	99,528	2,548	101,156
Ugo.......	340	13,498	118	4,685	345	13,697
Shinano ...	626	24,852	402	15,959	248	9,846
Ishikari ...	53	2,104	78	3,097	105	4,168
Iburi......	....	....	280	11,116	....	....
Kotsuke...	....	....	....	....	5	198
Total.	72,893	2,893,852	83,644	3,320,667	138,077	5,481,657

Province.	1896.		1897.		1898.	
	Koku.	Gallons.	Koku.	Gallons.	Koku.	Gallons.
Echigo	205,348	8,152,316	227,735	9,041,079	277,200	11,004,840
Totoumi...	2,424	96,233	2,758	109,493	2,800	111,160
Ugo.......	145	5,756	251	9,965	300	11,910
Shinano ...	322	12,783	323	12,823	350	13,895
Ishikari ...	37	1,469	140	5,558	100	3,970
Iburi......	220	8,734				
Kotsuke...	4	159	14	556	14	556
Total.	208,500	8,277,450	231,221	9,179,474	280,764	11,146,331

Production of crude petroleum and value of crude and refined oil sold in Japan in 1897 by provinces.

Province.	Production.		Value.	
	Koku.	*Gallons.*	*Yen.*	
Echigo	227,735	9,041,097	451,440	$230,686
Totoumi	2,758	109,493	14,426	7,372
Ugo	251	9,965	978	500
Shinano	323	12,823	905	462
Hokkaido (Ishikari, Iburi)	140	5,558	776	396
Kotsuke	14	556	21	11
Total	231,221	9,179,474	468,546	239,427

From the above table it is seen that the price of crude petroleum in 1897 was slightly over $1 per barrel.

The largest producing district, Echigo, which in 1898 produced 85 per cent of all the petroleum in Japan, is divided into subdistricts as follows:

Production of most important localities in Echigo in 1896, 1897, and 1898.

District.	Village.	1896.	
		Koku.	Gallons.
Koshi	Yamamoto and Nigoro	142,719	5,665,953
Naka-Kambara	Tsushima	24,024	953,758
Santo	Amaze	17,795	706,471
Kariba	Miyagawa	4,072	161,645
Nishi-Kubiki	Kami-Nadachi	2,446	97,087
Naka-Kubiki	Sugawara	2,370	94,073
Total		193,426	7,678,987

District.	Village.	1897.	
		Koku.	Gallons.
Koshi	Yamamoto and Nigoro	146,000	5,796,200
Naka-Kambara	Tsushima	30,000	1,191,000
Santo	Amaze	18,000	714,600
Kariba	Miyagawa	6,000	238,200
Nishi-Kubiki	Kami-Nadachi	5,000	198,500
Naka-Kubiki	Sugawara		
Total		205,000	8,138,500

Production of most important localities in Echigo in 1896, 1897, and 1898—Continued.

District.	Village.	1898.	
		Koku.	Gallons.
Koshi	Yamamoto and Nigoro	180,000	7,146,000
Naka-Kambara	Tsushima	30,000	1,191,000
Santo	Amaze	14,000	555,800
Kariha	Miyagawa	9,000	357,300
Nishi-Kubiki	Kami-Nadachi	7,000	277,900
Naka-Kubiki	Sugawara		
Total		240,000	9,528,000

The total product of petroleum in Japan by the State and private individuals from 1891 to 1896, inclusive, as given by official reports of Japanese Government, has been as follows:

Total product of petroleum in Japan, from 1891 to 1896.

[1 kwan = 8.2817 pounds.]

Year.	Kwan.	Year.	Kwan.
1891	*a* 520,480	1894	6,079,440
1892	*a* 537,640	1895	5,979,880
1893	*a* 437,640	1896	8,336,000

a Prepared oil.

The following table gives the current average prices of petroleum in the city of Tokyo, Japan, during the years 1890 to 1897:

Average prices of petroleum in Tokyo, Japan, from 1890 to 1897.

[From official reports of Japanese Government.]

Year.	Cask.		Year.	Cask.	
	Yen.	Dollars.		Yen.	Dollars.
1890	1.86	1.399	1894	1.77	.984
1891	1.67	1.388	1895	2.23	1.095
1892	1.68	1.252	1896	2.20	1.164
1893	1.75	1.157	1897	2.10	1.073

IMPORTS OF ILLUMINATING OIL.

The amount of kerosene oil imported into Japan from the United States in 1899 was much less than in 1898.

Practically all the illuminating oil used by Japan, Korea, and other far eastern countries is sent there from the United States, packed in tin cans holding 5 gallons each. In Korea these cans are considered a godsend by the natives, as they are used for almost every purpose imaginable. Modern hardware is an unknown quantity there, and all the household articles are beaten into shape by hand out of brass. The American oil cans are also transformed into stovepipes and water buckets. A wooden bar is inserted across the open top of the can for a handle, and these form the only buckets known in the country. Before the advent of the American oil can, stovepipes were never thought of.

We are indebted to the Japan-American Commercial and Industrial Association which has offices in New York City and Tokyo, Japan, for the following report of imports of petroleum from all sources by months during 1899, part of which is reported in cans and part in gallons:

Imports of petroleum to Japan in 1899.

Month.	1899.		1899.	
	Quantity.	Value.	Quantity.	Value.
	Cans.	*Yen.*	*Gallons.*	*Yen.*
January	3,219,860	436,936	2,137,826	185,465
February	8,765,150	1,181,122	540	65
March	4,162,027	596,263	1,599,764	134,322
April	6,097,595	861,853	42,260	4,317
May	2,919,910	474,473	1,622,982	152,812
June	2,287,570	319,377	13,238	725
July	2,197,760	357,708	1,187,856	164,164
August	480,010	68,860	1,251,055	128,504
September	2,822,840	576,532	....	....
October	2,314,725	405,930	1,954,986	280,023
November	2,844,180	580,661	....	....
December	3,588,575	717,053	860,125	230,984
Total	41,700,202	6,576,768	10,670,632	1,281,381

The total value of the cans and gallons of refined oils imported as shown in the above table was 7,858,149 yen or about $3,920,000.

Importation of petroleum into Japan from all sources from 1868 to 1899, inclusive.

Year.	Quantity.	Value.		Value of yen on Jan. 1.
	Gallons.	*Yen.*	*Dollars.*	*Cents.*
1868	31,954	7,236		
1869	5,867	1,662		
1870	52,711	21,516		
1871	152,296	72,170		
1872	446,804	160,608		
1873	1,000,959	330,599		
1874	1,291,179	306,723		
1875	2,775,354	573,671		
1876	2,888,729	444,134		
1877	2,682,252	605,598		
1878	10,687,753	1,803,076		
1879	16,799,642	2,185,223		
1880	14,895,892	1,400,471		
1881	8,007,200	979,112		
1882	20,682,205	2,320,905		
1883	23,631,055	2,456,261		
1884	17,534,885	1,773,361		
1885	17,636,020	1,667,722	1,430,905	85.8
1886	25,100,220	2,358,498	1,710,383	81.0
1887	21,058,865	1,871,428	1,467,200	78.4
1888	28,507,767	3,519,255	2,649,999	75.3
1889	36,998,843	4,587,135	3,366,957	73.4
1890	42,663,580	4,950,256	3,722,593	75.2
1891	40,482,160	4,535,720	3,769,183	83.1
1892	32,689,275	3,328,398	2,479,657	74.5
1893	49,763,392	4,401,041	2,909,088	66.1
1894	55,643,719	5,135,332	2,855,245	55.6
1895	44,152,414	4,303,929	2,116,175	49.1
1896	54,692,886	6,331,036	3,349,118	52.9
1897	61,058,217	7,667,350	3,918,017	51.1
1898	67,905,455	7,552,880	3,761,334	49.8
1899	(a)	7,918,921	3,943,623	49.8

a Not ascertained in gallons.

Quantity and value of petroleum exported from the United States to Japan from 1890 to 1899.

Year.	Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*	
1890	37, 892, 930	$3, 559, 375	51, 991	$14, 405
1891	31, 000, 629	2, 878, 861	53, 063	15, 716
1892	23, 761, 930	1, 798, 792	45, 410	13, 622
1893	26, 869, 510	1, 710, 480	53, 293	14, 492
1894	37, 272, 450	2, 209, 070	60, 299	17, 177
1895	24, 298, 170	1, 591, 751	238, 370	64, 941
1896	33, 701, 038	3, 060, 797	432, 367	88, 730
1897	46, 252, 501	4, 029, 459	1, 158, 625	192, 918
1898	51, 621, 050	3, 592, 587	1, 777, 115	222, 536
1899	32, 705, 180	2, 341, 922	897, 096	119, 553

The total exports to Japan from the United States in 1899 was 32,705,180 gallons, or 800,121 barrels, as compared with 1,271,385 barrels in 1898, showing a loss of 37 per cent, which is accounted for by the increased production of petroleum in Japan during 1899 and an increase in that exported from Russia and the Dutch East Indies.

Value of kerosene oil imported to Japan during the calendar years 1893 to 1898, by countries.

[Yen.]

Year.	United States.	Russia.	Dutch India.	Other countries.	Total.
1893	2, 599, 581	1, 801, 460			4, 401, 041
1894	4, 079, 352	1, 055, 980			5, 135, 332
1895	3, 039, 255	1, 217, 980		46, 694	4, 303, 929
1896	5, 282, 909	1, 013, 127		35, 000	6, 331, 036
1897	5, 971, 866	1, 336, 353		359, 131	7, 667, 350
1898	5, 910, 774	1, 133, 807	508, 299		7, 552, 880

Imports of petroleum oils to Japan, showing countries whence imported during the calendar years 1896, 1897, and 1898.

	1898.		1897.		1896.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Oil, kerosene:		*Yen.*		*Yen.*		*Yen.*
Dutch India...galls.	3,735,720	508,298.40	....	....	....	....
Russian Asia...do..	16,203,920	1,133,807.04	18,723,426	1,336,353.12	18,437,273	1,013,126.62
United States...do..	47,065,815	5,910,774.16	39,983,880	5,971,866.30	36,055,613	5,282,909.40
Other countries.do..	....	....	2,350,911	359,130.98	200,000	35,000.00
Total.............	67,005,455	7,552,879.60	61,058,217	7,667,350.40	54,692,886	6,331,036.02
Oil, lubricating:						
Germany.....catty.	15,045	2,507.94	27,402	2,193.26	33,535	3,504.52
Great Britain...do..	167,266	16,762.16	162,648	16,574.44	89,706	10,983.78
Russia..........do..	7,013	884.97	4,693	895.66	66,596	2,845.82
United States...do..	9,429,074	380,122.28	7,654,053	314,443.44	2,780,334	192,624.70
Other countries.do..	6,719	1,101.80	540	27.22	595	154.66
Total.............	9,625,117	401,379.15	7,849,336	334,134.02	2,970,766	210,113.48

From the above table it is seen that the United States furnished 71 per cent of the total amount of petroleum imported into Japan in 1898.

Imports of petroleum oils to Japan in first nine months of 1898 and 1899.

	1899.		1898.	
	Gallons.	Yen.	Gallons.	Yen.
Oil, kerosene:				
January to July (6 months)......	36,254,338	4,869,602	39,858,014	4,597,316
January to October (9 months)......	45,077,956	6,389,451	54,860,328	6,042,254
Oil, lubricating:	*Catty.*		*Catty.*	
January to July (6 months)......	3,420,123	176,637	4,368,171	198,215
January to October (9 months)......	4,631,607	241,756	8,172,917	334,149

1 catty or kin=1.3251 pounds (avoirdupois).

The total value of kerosene oil imported from all sources to Japan in the year 1899 was 7,918,921 yen, against 7,552,880 yen in 1898, an increase of 366,041 yen.

From the reports of consuls in Japan we obtained the following information:

The importation of kerosene oil from the United States into Japan was increased during the first six months of 1899 by the addition of 1,894,930 gallons. The average value of that export was 6.91 cents per gallon, or about one-third of a cent higher than during the same period in 1898.

According to the customs returns, the principal importations for the first six months of 1898 and 1899 were:

Imports of petroleum into Japan during first six months of 1898 and 1899.

Countries.	1898.	1899.	
	Quantity.	Quantity.	Value.
	Gallons.	*Gallons.*	
United States	22, 518, 414	24, 413, 344	$1, 686, 723
Russian Asia	9, 762, 495	8, 141, 748	452, 515
Dutch India	2, 590, 235	313, 630	25, 931
Total	34, 871, 144	32, 868, 722	2, 165, 169

It will be perceived that the gain in importation was all from the United States. Considerable activity is now being manifested in developing the oil wells in Japan, of which there are many. Generally speaking, the yield has not hitherto proved sufficiently productive to warrant extensive operation, but at present the outlook is more favorable. About one-third of the kerosene oil imported to Japan comes to the port of Kobe (Hiogo).

Aside from the principal use of kerosene oil, it is on the increase in Japanese towns and cities for lighting in front of dwellings and places of business, and also for burning in oil stoves and to run engines for driving rice-polishing mills.

Russian oil is received mainly in tanks on steamers; American oil only in tins. The Russian oil is afterwards distributed by rail, being conveyed in tanks; it is finally tinned for use. Langkat oil comes only in tins made in Langkat, cased in wooden boxes, the wood for which is shipped from Japan.

Less than two years since, there was considerable doubt as to the value of the numerous oil wells situated in Japan. It was thought that while a considerable quantity of oil might be produced from them, the cost of their operation would render them an unprofitable investment. But at present the outlook for oil production in Japan is far more favorable.

There are about 400 small wells in the prefecture of Nigata, one-half of which are in more or less successful operation, and it is understood negotiations are in progress for the purchase of many of the others.

As showing the increased interest in the oil wells of this country, it is said that an American company has already obtained possession of large oil interests here, with the view of producing for this market instead of exporting to Japan.

CHINA.

China depends almost entirely upon the United States, Russia, and Sumatra for its supply of petroleum. Owing to the sharp competition, the imports of American petroleum in China have fallen off very largely during the past year. Our total exports of illuminating oil show a decline of over 21,000,000 gallons, or nearly 50 per cent. The total consumption of petroleum in China amounts to about 100,000,000 gallons per annum. In 1897 the United States supplied 48 per cent of this amount, Russia 37 per cent, while the remaining 15 per cent came from Sumatra.

The British consul at Fuchau in a recent report to his Government says:

The keen competition of the Royal Dutch Petroleum Company's "Crown" or Langkat oil brought prices down to the lowest figure ever quoted, and this oil, from its cheapness, seemed destined to drive American and Russian kerosene out of the market, especially as preparations were made at Pagoda Anchorage to build tanks in order to import it in bulk, and a steam sawmill started at Fuchau to supply the cases. Toward the end of the year, however, rumors, which were afterwards verified, spread that the Langkat wells showed serious signs of running dry, at least for the time being; supplies thence slackened off, and prices went up with a bound. During the year the tank steamer *Sabine Rickmers* thrice brought full cargoes of Russian oil. The oil is tinned on board by Chinese. The Shell Transport and Trading Company's establishment on the north bank of the Min, at Fuchau, can turn out at least 2,000 tins per diem.

HINDRANCES TO AMERICAN OIL TRADE IN CHINA.

United States Consul Bedloe, of Canton, in his report to the Department of State for March, 1899, submitted the following:

The recent discovery of petroleum in the very heart of China, in the rich and populous province of Szechuan, is reported by the Tientsin correspondent of the Hongkong Telegraph, as follows:

"Very rich petroleum wells have been found near Chungking, which suggest endless possibilities in this line alone. These oil wells are said to be far superior to those discovered in Kyaochau, and more important than any yet worked by native methods; but they need foreign capital and management, with which, it is thought, they will yield large quantities of oil. Of course what would be required to place the product on a sound commercial basis would be a big oil refinery."

This discovery is very important, and in view of the oil wells in the Japanese island of Formosa, and of other oil wells near the German possession of Kyaochau, in the province of Shantung, our trade in American kerosene is bound to be affected unless prompt efforts are made to control the output and, if possible, the trade in the Chinese product.

We have already in this growing district of Canton—which has over three times the area and population it had in 1896, and which comprises the three provinces of Kwangtung, Kwangsi, and Yunan, with more than 80,000,000 of people—two powerful competitors in Russian and Dutch oils, as will be seen by the customs statistics of the trade at Canton. Until 1896 Dutch oil was unknown in China. It comes from Sumatra, and the Royal Dutch Petroleum Company is vigorously pushing it in Hongkong and Chinese coast ports, including the seven treaty ports in this consular district, viz, Swatow, Macao, Hoihow, Pakhoi, Canton, Samshui, and Wuchow. The inland waters of China were opened to the trade of all nations on June 1, 1898, and this extension of markets will afford greater facilities for increasing our commerce in China.

In 1896 the German agents for the Dutch oil purchased a site in Hongkong, built a pier for the use of tank steamers, and constructed several large reservoirs to store oil in bulk, as well as warehouses for canning and boxing the same. Our Dutch rivals in kerosene began to develop their enterprise with characteristic energy, and in 1897, after just one year, had such a demand that it was necessary to run several tank steamers between Sumatra and Hongkong to supply the constantly increasing market in China for cheap oil. Previous to the erection of these tanks by the Royal Dutch Petroleum Company, oil was imported in cases of two cans each.

In these oil works in Hongkong there were canned in 1897 upward of 2,600,000 gallons of oil for the Canton market alone. Customs returns show 2,025,780 gallons of American oil imported into Canton between January, 1894, and January, 1897. Of Russian oil there were imported during the same period 2,703,320 gallons.

The Dutch oil is an inferior article and much cheaper, of course, than that from America. It is well known that large quantities of Dutch oil are being palmed off on the unsuspecting Chinese as genuine American kerosene. It is canned in Hongkong in old American tins that are bought throughout China for that purpose at 10 cents a tin, and are marked with popular American trade-marks of various kinds. The Chinaman is a practical business man, and if he can buy Dutch or Russian oil, or, as is frequently the case, a combination of both these smoky, inflammable, and dangerous oils, made up in a way that will enable him to sell it in China as American "Brilliant," "Comet," "Sunlight," or other popular brands, and at a lower price than the genuine article, he will, of course, jump at the opportunity. At Wuchow (opened to trade in June, 1897), British, German, and other agencies were soon established, and besides "pushing" piece goods, thread, cheap lamps, matches, etc., they introduced Russian and Dutch oil into the innumerable cities, towns, and villages on the great West River and its various branches, where our oil had held the market until last year.

The whole of the great West River and all the inland waters of China are now open to the navigation and the trade of all nations. American exporting firms can establish agencies in the great trade centers of this vast district, which has more than 1,000 miles of seacoast, including the large island of Hainan, and which extends into the interior as far as Tibet, a distance of over 2,000 miles. This territory is larger in area and in population than that of Austria, Germany, France, and Spain combined, and probably will be as important to United States trade.

The United States is fully able to supply the demands of this great market, and vigorous efforts should be made to do so. We have active and determined competitors in the field. For many years our oil producers supplied China's millions. We can now send our oil hundreds of miles into the interior under the American flag. We should hasten to avail ourselves of this opportunity. With increased competition should come increased effort.

American trade with the Far East in recent years has not, in certain lines, increased as rapidly as has that of other countries. In no branch of commerce is this more evident than in oil. In 1894 imports into Shanghai in this line were:

	Gallons.
American oil	36,241,924
Russian oil	4,059,700
Dutch oil	*None.*

In 1897 our oil remained about the same, while Russian oil rose to over 20,000,000 gallons, and Dutch oil, of which there were no exports in 1894, rose to 1,581,000 gallons in 1896 and to 5,570,400 gallons in 1897.

Notwithstanding the great increase in the demand in China during the past four years, we have not received our share of the oil trade.

The Dutch product has advantages in freight and difference in exchange. The points whence American oil is shipped to the Far East are thousands of miles away. Would it not be advisable to select some point on the Pacific coast for the export of oil to China? We could ship oil in tank steamers across the Pacific to the Chinese markets quicker and cheaper than is possible by sailing ships, as at present. The old methods were good when we monopolized the market; now, however, we must find better ones.

Consul Smithers, at Hongkong, about the same time recommended that refiners of American oil establish depots throughout China for

the sale of their product, with foreigners as agents. He believes that such a plan would prove of great value in increasing the demand and in securing to consumers unadulterated oil. He also suggests the introduction of a noncombustible lamp. A great many fires originate in China through the use of defective lamps, and in some cities proclamations have been issued forbidding the use of kerosene oil and stopping its importation. These orders have since been rescinded, but they have operated to a large extent in limiting the consumption of illuminating oil.

Exports of refined mineral oil from the United States to China, 1890 to 1899.

Year ending June 30—	Naphthas, including all lighter products of distillation.		Illuminating.		Lubricating and heavy paraffin oil.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
1890			13, 072, 000	$1, 251, 201	2, 669	$1, 888
1891			27, 160, 660	2, 586, 321	20, 518	5, 339
1892			17, 370, 600	1, 249, 215	3, 367	1, 810
1893			27, 874, 230	1, 808, 026	3, 825	1, 411
1894			40, 377, 296	2, 435, 794	9, 793	2, 842
1895			18, 022, 800	1, 175, 173	20, 675	6, 037
1896			25, 694, 890	2, 158, 800	48, 322	8, 178
1897	250	$40	42, 516, 120	3, 352, 935	110, 814	18, 962
1898	1, 250	125	44, 324, 344	2, 839, 345	197, 958	25, 625
1899	1, 000	150	22, 683, 425	1, 791, 108	185, 368	25, 307

This table shows a falling off of nearly 50 per cent in the exports to China from the United States in 1899, as there was a large amount shipped from Sumatra in 1898, full supplies were shipped from the United States, and a fair supply from Russia, which were not consumed during that year but were held over and consumed in 1899, thereby decreasing the amount exported in that year.

Quantity and value of kerosene oil imported into the Chinese Empire, 1886 to 1898.

Year.	American.		Russian.	
	Gallons.	Haikwan taels.(a)	Gallons.	Haikwan taels.(a)
1886	(b)	(b)	(b)	(b)
1887	(b)	(b)	(b)	(b)
1888	(b)	(b)	(b)	(b)
1889	14, 999, 942	2, 178, 722	5, 655, 471	696, 768
1890	23, 591, 113	3, 262, 049	7, 237, 611	830, 825
1891	39, 348, 477	4, 308, 839	10, 000, 902	958, 212
1892	31, 884, 013	3, 330, 116	8, 649, 318	872, 795
1893	36, 720, 382	4, 086, 661	13, 286, 198	1, 484, 534
1894	51, 670, 853	5, 905, 228	17, 500, 283	2, 036, 175
1895	23, 055, 940	3, 098, 214	26, 566, 979	3, 195, 106
1896	33, 520, 649	4, 833, 573	28, 285, 000	3, 521, 873
1897	48, 212, 505	6, 935, 155	36, 924, 125	4, 618, 148
1898	50, 084, 015	6, 797, 922	19, 926, 246	2, 202, 244

Year.	Sumatran.		Total.	
	Gallons.	Haikwan taels.(a)	Gallons.	Haikwan taels.(a)
1886	....	....	23, 038, 101	2, 211, 000
1887	....	....	12, 015, 135	1, 365, 000
1888	....	....	16, 613, 090	2, 219, 332
1889	....	....	20, 655, 413	2, 875, 490
1890	....	....	30, 828, 724	4, 092, 874
1891	....	....	49, 349, 379	5, 267, 051
1892	....	....	40, 533, 331	4, 202, 911
1893	....	....	50, 006, 580	5, 571, 195
1894	534, 280	63, 911	69, 705, 416	8, 005, 314
1895	2, 395, 035	321, 977	52, 017, 954	6, 615, 297
1896	5, 151, 873	727, 875	66, 957, 522	9, 083, 321
1897	14, 212, 278	1, 745, 833	99, 348, 908	13, 299, 136
1898	26, 871, 865	2, 914, 533	96, 882, 126	11, 914, 699

a Value of Haikwan tael on January 1, 1888, in United States money, $1.151; 1890, $1.148, 1891, $1.27 1892, $1.137; 1893, $1.01; 1894, $0.849; 1895, $0.749; 1896, $0.808; 1897, $0.78; 1898, $0.697; 1899, $0.722; 1900, $0.742.

b Not ascertained.

One tael = 1⅓ ounces of silver (troy).

Quantity of kerosene oil imported at port of Chefoo, 1892 to 1899.

[Gallons.]

Year.	America.	Russia.	Sumatra.
1892	1,056,580		
1893	2,255,870		
1894	1,833,790		
1895	1,967,900		
1896	2,388,250	610,000	
1897	5,281,060	577,800	
1898	4,500,060	109,940	142,000
1899 (six months)	1,351,040		

Quantity and value of kerosene oil imported at port of Shanghai in 1897.

Imported from—	Quantity.	Value.
	Gallons.	*Haikwan taels.*
America	36,909,060	5,194,481
Russia	17,467,940	2,293,357
Russia, in bulk	7,411,900	718,960
Sumatra	3,218,395	401,239
Sumatra, in bulk	2,352,028	231,914
Total	67,359,323	8,839,951

INDIA.

The provinces that produce petroleum in India are Burma, Assam, Punjab, and Baluchistan. Burma, however, furnished 92 per cent of the total output for 1898, Assam furnished practically all the remainder, as the two last named did not furnish any marketable quantity. The whole production in India in 1898 was 18,972,368 gallons (imperial gallons), equal to 542,068 barrels.

In 1897–98 there were 87,000,000 gallons of refined petroleum imported into India, of which about 52,000,000 gallons came from the United States, 27,500,000 from Russia, and 7,500,000 from Sumatra. During 1898–99 the latter amount declined to 4,500,000 gallons.

THE BURMA FIELD.

The province of Burma is located in the extreme eastern portion of India, next to the empire of China, and is drained by the Irawaddy River, on whose banks most of the development is found. It has been worked by the primitive method of shafts for many years. There is still a large amount obtained by this method.

These shafts or pits are from 50 to 350 feet in depth and are excavated by hand labor. Some of these shafts produce only one-half a barrel, while others produce as much as 60 barrels a day. All of the petroleum from these shafts is hoisted out with a bucket and windlass by hand labor. There are a large number of these shafts or pits at Twingoon, Beme, and Pagan.

There are 150 drilled wells at Yenangyoung and Pagan. At the former locality there are about 100 of them that were deepened from 400 to 800 feet with good results. There are about 50 drilled wells in the Pagan field, 60 miles to the north, that are about 1,200 feet deep and produce a much lighter petroleum than that found near Yenangyoung. Nearly all of the material passed through in drilling is of a soft nature, made up of compact clay and sand, which has to be cased close up to the drill. The petroleum is found in a dark, sharp sand, loosely cemented. Both of these principal fields have short pipe lines that extend to the Irawaddy River, where it is loaded in boats and floated to the refineries at Rangoon, operated by the Burma Oil Company.

The following table shows the production of petroleum in India from 1889 to 1898. The record of production for 1899 has not yet been secured:

Production of petroleum in India from 1889 to 1898.

Year.	Production.	
	Imperial gallons.	Barrels (42 U. S. gallons).
1889	3,298,737	94,250
1890	4,931,093	140,888
1891	6,136,495	175,328
1892	8,725,331	249,295
1893	10,359,812	295,994
1894	11,450,906	327,169
1895	13,013,990	371,828
1896	15,057,094	430,203
1897	19,128,828	546,538
1898	18,972,368	542,068

In the following table is given the production of petroleum in India, by British provinces and native States, from 1895 to 1898:

Production of petroleum in India from 1895 to 1898.

Province or State.	1895.			1896.		
	Quantity.	Value.		Quantity.	Value.	
	Gallons.	*Rupees.*	*Dollars.*	*Gallons.*	*Rupees.*	*Dollars.*
Assam	36,435	7,287	1,574	238,730	23,873	5,562
Burma	12,975,995	1,534,951	331,549	14,816,000	1,769,145	412,211
Punjab	1,560	353	76	2,364	337	79
Total	13,013,990	1,542,591	333,199	15,057,094	1,793,355	417,852

Province or State.	1897.			1898.		
	Quantity.	Value.		Quantity.	Value.	
	Gallons.	*Rupees.*	*Dollars.*	*Gallons.*	*Rupees.*	*Dollars.*
Assam	*a* 222,077	*b* 22,208	4,997	547,965	57,680	11,594
Burma	18,904,710	2,241,289	504,290	18,424,403	960,640	193,088
Punjab	2,041	275	62	....	....	....
Total	19,128,828	2,263,772	509,349	18,972,368	1,018,320	204,682

a The decrease in the quantity and value is partly due to the fact that the Assam Oil Syndicate, which extracted a small quantity of oil in 1896, did not work in 1897, and partly to ordinary fluctuation.

b Value of the crude or unrefined oil at the well.

The value of the rupee on January 1, 1885, in United States money was 37.8 cents; 1886, 35.7 cents; 1887, 34.6 cents; 1888, 32.2 cents; 1889, 32.3 cents; 1890, 33.2 cents; 1891, 36.6 cents; 1892, 32.8 cents; 1893, 29.2 cents; 1894, 24.5 cents; 1895, 21.6 cents; 1896, 23.3 cents; 1897, 22.5 cents; 1898, 20.1 cents; 1899, 20.6 cents; 1900, 32.4 cents.

The following table shows the internal distribution of refined petroleum in India. The first part shows where it was carried under the head of imports. The second portion shows whence it was reshipped under the head of exports. It will be seen that 30,319,032 gallons of oil were carried on the railways and rivers of India during the year. Bengal was the largest importing province, having taken 11,583,656 gallons, of which practically the whole was received from Calcutta. After Bengal the northwest provinces and Oudh would appear to be the most important provinces, the imports into which were 3,353,880 gallons, of which the Bengal province, and not Calcutta, was the chief source of supply. In 1896–97 Bombay would appear to have been the third most important receiving province. Assam may be spoken of as fourth, with 2,442,296 gallons, derived exclusively from Bengal and Calcutta. The Punjab, fifth in order of demands, 2,122,320 gallons, the supply being derived mainly from Bengal and Karachi. It is perhaps hardly necessary to mention other particulars, except that the

exporting centers are as follows: Calcutta, 13,155,976 gallons; Bombay, port town, 7,123,864 gallons; Madras ports, 1,955,232 gallons, and Karachi, 1,521,472 gallons.

Quantity and value of petroleum (kerosene) carried by rail and river in British India.

Imports to—	April 1, 1894–March 31, 1895.		April 1, 1895–March 31, 1896.		April 1, 1896–March 31, 1897.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
British provinces (excluding chief seaports).	*Gallons.*	*Rupees.*	*Gallons.*	*Rupees.*	*Gallons.*	*Rupees.*
Madras	1,576,448	861,151	1,551,144	1,030,396	2,011,504	1,462,438
Bombay	2,141,760	1,137,811	2,077,744	1,395,962	3,229,104	1,816,423
Sind	93,800	45,526	135,856	70,056	183,920	100,599
Bengal	5,912,064	2,956,162	7,672,544	3,836,488	11,583,656	6,156,663
Northwest provinces and Oudh	4,125,168	2,068,153	3,923,280	1,976,248	3,353,880	1,786,564
Punjab	2,164,336	1,059,432	1,935,848	995,170	2,122,320	1,155,639
Central provinces	2,109,832	1,092,105	1,896,640	1,066,996	1,673,424	922,068
Berar	1,095,576	581,963	1,039,360	1,693,641	995,592	560,031
Assam	1,284,288	642,144	1,988,600	994,300	2,442,296	1,297,470
Total	20,503,272	10,444,447	22,221,016	12,059,257	27,595,696	15,257,895
Native States.						
Rajputana and Central India	1,288,816	687,004	1,191,392	789,299	1,234,424	708,743
Nizams Territory	493,848	266,738	443,304	295,729	539,944	359,425
Mysore	765,256	415,326	822,336	547,860	882,352	583,727
Total	2,547,920	1,369,068	2,457,032	1,632,888	2,656,720	1,651,895
Chief seaports.						
Madras ports	28,096	15,361	20,216	13,429	62,624	45,134
Bombay	1,344	714	944	629	3,080	1,733
Karachi	104	66	3,088	2,029	32	19
Calcutta	1,537,272	768,636	7,304	3,668	880	467
Total	1,566,816	784,777	31,552	19,755	66,616	47,353
Grand total	24,618,008	12,598,292	24,709,600	13,711,900	30,319,032	16,957,143
Exports from—	**Quantity.**	**Value.**	**Quantity.**	**Value.**	**Quantity.**	**Value.**
British provinces (excluding chief seaports).	*Gallons.*	*Rupees.*	*Gallons.*	*Rupees.*	*Gallons.*	*Rupees.*
Madras	153,616	84,009	92,848	61,657	44,320	35,664
Bombay	700,432	372,104	646,472	434,349	468,600	263,588
Sind	103,808	50,282	24,560	12,664	10,968	5,998
Bengal	7,204,968	3,602,484	6,952,720	3,476,360	5,835,344	3,100,025
Northwest provinces and Oudh	54,408	34,005	112,608	84,456	114,208	85,656
Punjab	21,976	14,079	21,800	15,328	29,824	19,572
Central provinces	7,152	4,973	10,880	8,501	16,856	13,432
Berar	72	46	216	140	7,792	4,870
Assam	5,736	2,868	1,072	586	3,480	1,849
Total	8,252,168	4,164,850	7,863,176	4,094,041	6,531,392	3,530,654

Quantity and value of petroleum (kerosene) carried by rail and river in British India—Continued.

Imports to—	April 1, 1894–March 31, 1895.		April 1, 1895–March 31, 1896.		April 1, 1896–March 31, 1897.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Native States.						
	Gallons.	*Rupees.*	*Gallons.*	*Rupees.*	*Gallons.*	*Rupees.*
Rajputana and Central India	4,240	2,821	1,472	1,095	5,040	3,973
Nizams Territory	1,392	761	296	196	792	505
Mysore	9,104	4,979	9,224	6,130	25,264	20,320
Total	14,736	8,561	10,992	7,421	31,096	24,798
Chief seaports.						
Madras ports	2,220,784	1,214,491	2,286,112	1,518,121	1,955,232	1,573,350
Bombay	5,527,776	2,936,631	4,671,472	3,138,646	7,123,864	4,007,174
Karachi	1,760,864	852,919	943,840	486,667	1,521,472	832,055
Calcutta	6,841,680	3,420,840	8,934,008	4,467,004	13,155,976	6,989,112
Total	16,351,104	8,424,881	16,835,432	9,610,438	23,756,544	13,401,691
Grand total	24,618,008	12,598,292	24,709,600	13,711,900	30,319,032	16,957,143

The following table shows the coastwise traffic in kerosene and other mineral oils from 1890 to 1897:

Coastwise traffic in kerosene and other mineral oils.

[Gallons.]

Year.	Kerosene.		Other kinds.		Total.	
	Indian.	Foreign.	Indian.	Foreign.	Indian.	Foreign.
Imports.						
1890–91	43,072	5,015,418	971,307	9,111	1,014,379	5,024,529
1891–92	24,051	4,662,411	1,402,448	19,088	1,426,499	4,681,499
1892–93	137,187	6,249,654	1,456,066	29,954	1,593,253	6,279,608
1893–94	193,340	7,633,678	1,593,359	45,158	1,786,699	7,678,836
1894–95	252,519	6,432,052	1,822,521	53,728	2,075,040	6,485,780
1895–96	417,315	6,163,791	2,314,509	65,898	2,731,824	6,229,689
1896–97	286,761	6,560,700	2,899,366	104,421	3,186,127	6,665,121
Exports.						
1890–91	1,016,842	7,379,770	....	17,148	1,016,842	7,396,918
1891–92	2,871	7,411,310	1,435,625	25,671	1,438,496	7,436,981
1892–93	172,267	9,252,503	1,459,603	51,453	1,631,870	9,303,956
1893–94	285,888	11,797,543	1,589,018	72,997	1,874,906	11,870,540
1894–95	359,750	9,285,444	1,812,103	98,677	2,171,853	9,384,121
1895–96	403,561	9,509,436	2,279,013	133,827	2,682,574	9,643,263
1896–97	999,215	10,324,381	2,421,947	177,964	3,421,162	10,502,345

In the above table it will be observed that effort has been made to distinguish Indian from foreign petroleum. In calculating quantities the Bengal standard of 280 gallons to the ton is employed.

The Indian Engineering says that there has been an enormous increase in the export trade of Burma oil, which aggregated 736,844 gallons in 1898–99, as compared with 15,467 gallons in 1897–98, which was wholly due to the very large shipments of locally refined kerosene oil from Rangoon to Penang, the exceedingly small output of crude oil from the wells at Langkat in Sumatra having curtailed supplies of kerosene oil from Sumatra to Penang, which had, in consequence, to get oil from Rangoon.

The following is a statement of the quantity of kerosene oil imported into British India by sea from foreign countries, as given in Review of Mineral Production in India:

Quantity of kerosene oil imported into British India by sea from foreign countries from 1886 to 1899.

Year.	Quantity.	Value.
	Gallons.	*Rupees.*
1886–87	30,963,763	...
1887–88	30,200,042	...
1888–89	38,285,559	...
1889–90	51,839,400	...
1890–91	54,235,275	23,622,192
1891–92	58,109,283	23,681,405
1892–93	67,085,968	26,902,640
1893–94	86,608,568	32,755,852
1894–95	53,441,425	21,229,994
1895–96	66,648,001	29,674,004
1896–97	64,471,307	28,593,560
1897–98	[a] 87,000,000	...
1898–99	[a] 82,000,000	...

[a] From consular report, and is approximate.

The export from the United States to British East Indies for the year ending June 30, 1899, was as follows:

Exports of petroleum to British East Indies for year ending June 30, 1899.

Kind of oil.	Quantity.	Value.
	Gallons.	
Illuminating	20,109,900	$1,408,257
Lubricating	4,359,824	392,162
Total	24,469,724	1,800,419

The consul at Bombay makes the following statement:

Quantity and value of kerosene imported into Bombay, 1897–98 and 1898–99.

Article.	1897–98.			1898–99.		
	Quantity.	Value.		Quantity.	Value.	
Kerosene:	*Gallons.*	*Rupees.*		*Gallons.*	*Rupees.*	
In bulk	4,773,988	2,097,600	$421,618	4,576,558	1,716,207	$353,539
In cases	25,230,782	10,675,158	2,145,707	21,461,215	8,772,228	1,807,079
Other sorts........	1,174,952	907,568	182,421	1,032,369	784,570	161,621

The falling off in imports is probably only temporary, and was largely due to heavy stocks of previous years. During the last year 22,000,000 gallons were imported from Russia, while but little over 3,000,000 gallons came from America, about one-half less than during the previous year. The American oil is superior, and sells for a higher price than its competitor. The Sumatra oil wells have not met expectation, and have given short supplies.

Value of mineral oil imported from the United States into Bombay from 1894 to 1899.

Year.	In cases.	Other kinds.
1894–95....................................	$989,747	$106,546
1895–96....................................	506,885	58,353
1896–97....................................	932,914	110,363
1897–98....................................	1,002,916	178,826
1898–99....................................	512,546	150,127

TURKEY.

A correspondent of the Petroleum and Technical Review reports the discovery of petroleum in Turkey as follows:

A new oil field has lately been discovered in Turkey. It is situated on Messrs. Gilchrist & Dawson's concessions, abutting on the Sea of Marmora, where oil has been struck at a depth of about 40 meters. Last summer Mr. Adiassewich surveyed this district on behalf of a London firm, and, acting on his advice, a well was sunk, with the result that the first thin oil-bearing layer was reached at a depth of about 40 meters, yielding on the first day a few hundred pounds of crude oil. The oil is said to be light and of very good quality.

The market price of crude oil in Turkey is rapidly rising, notwithstanding that Roumanian oil has lately found its way here. This is explained by the absence of facilities for shipping Roumanian oil in bulk. Though the freights are greatly in favor of the Roumanian oil, the expenditure for barrels, cases, etc., prevents the rapid increase in the importation of this oil into Turkey.

EGYPT.

Imports of American oil into Egypt are quite small, the country of the Khedive receiving the greater amount of its supply of petroleum from Russia.

According to English reports, the imports of petroleum into Egypt during the past four years have been as follows:

Imports of petroleum into Egypt from 1896 to 1899.

Year.	Quantity.	Value.
	Cases.	
1896	991,537	£163,565
1897	1,274,808	196,808
1898	1,222,484	174,605
1899	856,855	137,552

£ Egyptian = £1 0s. 6.154 d. sterling.

The import values were divided as follows:

Value of petroleum imported into Egypt from 1896 to 1899.

Year.	Russia.	America.	Other countries
1896	£133,126	£30,420	£19
1897	167,470	29,338	
1898	153,106	21,499	
1899	131,051	6,303	198

The local market follows the fluctuations of prices at Batum, American oil keeping about 1 franc per case higher than Russian. The latter is used entirely by the lower classes for lighting purposes, and it is expected that as gas and electricity come more into vogue among the upper classes the importation of American oil will decrease. A company recently formed has constructed several tanks for the storage of petroleum in bulk in Alexandria, but has not yet commenced importing. Another company has constructed tanks at Suez, with the object of importing petroleum from Borneo, both for supplying steamers and for distribution throughout Egypt.

There have been numerous reports of petroleum discoveries along the Nile, and syndicates of American, English, and Egyptian capitalists have been formed to explore the territory, but up to the close of 1899 the work had not passed the experimental stage and nothing definite had been given out in regard to the success of the wells or the amount of their probable yield.

SOUTH AFRICA.

Considerable interest has been aroused over the alleged discovery of petroleum shale in South Africa, and Consul Stowe has furnished the following information on the subject:

For the past twenty years well-authenticated instances of deposits of oil-bearing shale in the Orange Free State, Griqualand West, and elsewhere have occurred, and in 1889 a company having a large capital was floated with a flourish of trumpets to work some alleged oil-bearing ground in the Orange Free State, only to end in disaster when it was found that the oil was conspicuous by its absence. In Natal, also, traces of oil have from time to time been discovered in what has been declared to be true oil-bearing strata, but nothing appears to have been done to follow up the discovery. But most important of all are the reputed oil fields at Ceres, in the Cape Colony. These are said to cover an extent of upward of 200,000 acres. If oil should eventually be found here in good quantity, this would be one of the largest oil-bearing districts in the world. What is, however, most surprising about all these so-called petroleum discoveries in South Africa is that development stops after some progress has been made. The Ceres oil fields is a case in point. As far back as 1895 the colonial papers teemed with references to the reputed discoveries of vast oil deposits at Ceres, and the mineral rights over the several farms on which the petroleum was said to occur were promptly secured by a Kimberley syndicate. Active prospecting work was undertaken and considerable talk of deep boring, to prove the value of the ground, was indulged in, but up to the present nothing, so far as known, has been done to put the discovery to the test. This can not be explained on the supposition that the deposits have belied their earlier promise, for, although exhaustive testing by proper boring has certainly not been carried through, competent experts have testified to the probability of petroleum being struck when a certain depth has been reached. The Ceres fields, they declare, are of the true oil-bearing formation, lying in their original positions, undisturbed by igneous upheaval. Yet their development inexplicably hangs fire. In some quarters the blame for this is laid on the too exorbitant demands of the syndicate in whom the mineral rights are vested, whose unbusinesslike methods have frustrated all attempts to test or exploit the property, while in other quarters it is said that those who have been willing to provide the funds for the sinking of deep bores to test the value of the alleged deposits have been outrageously exacting in their terms. A few thousand pounds judiciously spent would speedily determine the matter one way or the other.

The extent of the oil trade with South Africa is seen by the enumeration of the figures of the total imports into that country. For instance, in 1897 paraffin and other lamp oil was imported of a declared value of £123,602 ($601,509), of which the Transvaal share was £48,546 ($236,249). The total imports for 1896 amounted to £112,671 ($548,313). In addition to oil for illuminating purposes, South Africa consumed lard, machine, and other oils of the declared value of £154,094 ($749,898) in 1896 and £121,680 ($592,156) in 1897, making a grand total of £266,765 ($1,298,212) and £244,682 ($1,190,745), respectively, for the two years.

NORTHERN AFRICA.

ALGERIA.

Consul Skinner, of Marseilles, sends the following, dated April 27, 1900:

Mr. Henry Neuberger, intrusted by the governor-general with a geological exploration in Algeria, has furnished information as to the first part of his expedition into the department of Oran. According to his report, the West Algerian petroleum-bearing basin offers fourteen districts rich in oil, extending northwest to southeast for a length, in the southern district, apparently exceeding 124 miles. If the report of the discovery is reliable, the nature of these soils is in all respects similar to that of the rich beds of Baku and Galicia; this promises a prosperous future for petroleum exploitation in Algeria. On the other coast petroliferous levels reappear in the department of Constantine. Applications for concessions to work these beds have already been made by ten or more financial companies.

NEW ZEALAND.

Mr. Henry A. Gordon, F. G. S., inspecting engineer of the department of mines, several years ago made a thorough exploration of the deposits of petroleum in New Zealand under the direction of the Government. The department report says:

In his report Mr. Gordon said that he found "small quantities of petroleum, with numerous jets of carburetted hydrogen gas bubbling up here and there along the ocean beach on the north side of the breakwater of New Plymouth for a distance of 300 yards. These can only be seen at low water, as the foreshore is covered with a thick deposit of iron sand. Wherever the shore is clear of this sand traces of oil can be seen on lifting the bowlders, and also, in sinking down in the soft volcanic deposit, the ground to some extent is saturated with it. The harbor engineer informed me that, in carrying on dredging operations for the breakwater, petroleum was found until the end of the breakwater was reached and that it can always be seen on the surface of the sea between the Mikotani and the Moturoa islands in fine weather." These two islands belong to a series called the Sugar Loaf Islands. Two different attempts have been made, under local auspices, to obtain oil by sinking wells on these islands, but the operations were conducted in the infancy of the oil business—one of them twenty-four years ago—when boring for oil had not reached its present pitch of perfection. In both cases, however, deposits of oil were found. "Traveling inland," reported Mr. Gordon, "I found that several people had sunk wells, but afterwards filled them up, as the water had a strong taste of kerosene. Mr. Kingdon, a settler in the locality, stated that he sunk a well some 60 feet, and the water found at the bottom of the well could not be used for domestic purposes, and he therefore filled it up again. The surface of the ground where this well was sunk is about 380 feet above the sea level and 1½ miles in a direct line from the sea-beach, where the petroleum oozes out of the surface." Going still farther inland he found a flat valley about 630 feet above the sea level. Several settlers here informed him that they had sunk wells for water, but could not use it owing to its impregnation with petroleum.

The Taranaki oil fields enjoy one important advantage over those of Russia and America. They are situated on the very seaboard, alongside the port of New Plymouth; whereas the oil of Pennsylvania has to be piped 300 or 400 miles to the export refiners on the coast, and that of Baku conveyed by railway 560 miles to Batum.

To diminish the heavy cost of railway transport, the Russians have long talked of spending a million and a half sterling in putting down an 8-inch crude oil pipe line from Baku to the Black Sea. No such costly outlay would be involved in the case of New Zealand. In addition, there is no market in the world more remote from both Russia and America than New Zealand, so that if a large local supply were tapped, it would enjoy this advantage of distance from competing rivals, as well as the tariff advantage of 6d. a gallon duty on all foreign kerosene imported into the country. Should, therefore, boring in the Taranaki district tap a copious petroleum supply, New Plymouth will benefit in a double manner from the success; she will not only be enabled to supply with kerosene, lubricating, and other oils the market of Australasia, and perhaps even India, but will also be equipped with fuel to smelt the enormous beds of iron ore at present lying unworked for want of a cheap smelting agent.

PERSIA.

Mr. H. Winklehner, who spent several years exploring for petroleum, rock salt, and other minerals in Persia, states that there are a number of springs of hot water that carry petroleum near Scluschter and Daliki, and this petroleum is collected in a small way by the natives.

NATURAL GAS.

By F. H. Oliphant.

INTRODUCTION.

The total value of the natural gas produced and marketed in the United States in 1899 was $20,024,873, while that of 1898 was $15,296,813, showing a gain of $4,728,060. This gain is due in part to the slight increase in prices charged consumers and in part to the securing of more complete returns, but mainly to the increased amount of natural gas produced and marketed.

This gain has been accomplished against a declining pressure in all of the old fields. There was little new territory developed during the year, except in the extreme southwestern portion of Pennsylvania and a portion of West Virginia, in which some virgin territory that has not felt the drain of adjacent wells was developed. The increased delivery is due principally to the enlargement and multiplication of the pipe lines of the old companies, the application of the gas compressor on a large scale, and the more careful manipulation of the wells and lines so as to anticipate the requirements of the consumers.

West Virginia made the largest increase of any of the gas-producing States. There were four large companies operating in the State during the year, which conveyed the product into Pennsylvania and Ohio for consumption. They are responsible for the large increase in the natural-gas output of West Virginia.

The total number of wells producing gas reported at the close of 1898 was 8,453, and at the close of 1899, 9,333. This is an increase of 880 wells, or over 10 per cent on the number at the close of the preceding year. The increase in the value of the gas sold during 1899 was 31 per cent over 1898.

Of the total value of natural gas produced in 1899 the Appalachian fields supplied 60 per cent and the Lima-Indiana fields 37 per cent, leaving but 3 per cent of the value for the production of all the other fields in the United States.

CONDITIONS OF PRODUCTION.

The conditions under which natural gas is produced in the Appalachian and Lima-Indiana gas fields are somewhat similar, although in

the first the gas is derived from a series of more or less porous sandstones, while the latter is found in the porous strata near the top of the massive Trenton limestone. The Appalachian sandstones containing the gas are found on the flanks and summits of long lines of uplifts in the strata. The gas of the Lima-Indiana field is collected along the flanks and summits of the great gradual swells of the Cincinnati uplift. In the Appalachian regions there are a series of waves in the structure, forming high ridges with troughs or depressions between, known geologically as anticlinals and synclinals. These "rock waves" have gently curved arches and gradually sloping flanks, and they follow a general northeast and southwest course to the west and northwest of the main Appalachian chain of mountains, and in a measure parallel with them. Beginning in western New York, these parallel folds can be traced with some irregularities and modifications into eastern Kentucky, crossing Pennsylvania and West Virginia, with outlying minor fields in southeastern Ohio. In sections these parallel ridges are disturbed by cross anticlinals and the lines themselves are offset in several localities. The denudation of these uplifts has evened up the general surface, so that they are not usually prominent in the topography of the section.

The whole series, with their folds, have a general southwestern dip from western New York to a point near Parkersburg, West Virginia, which averages 17 feet to the mile until West Virginia is reached, where it flattens off. From this lowest point the measures are almost level for miles, gradually rising in all directions.

Near the eastern edge of this level area there is a remarkable sudden uplift or anticlinal, extending almost due south from St. Marys, West Virginia, to Spencer, in Roane County, West Virginia, a distance of 40 miles.

On the flanks of these folds and at their crests, where the rocks are at the greatest elevation, the large reservoirs of gas are found. The main gas-producing territory of the Appalachian region begins a few miles northwest of Parkersburg, and, with the exception of a few barren sections and offsets in direction, it is almost continuous in a northeast direction as far as western New York. That portion to the southwest from Parkersburg, West Virginia, into Kentucky and Tennessee is lacking in the regular structure of the section to the northeast, owing to the thickening of the measures below the Pittsburg coal, which has to a large extent counteracted the folds found on the surface. In this portion of the Appalachian field, however, there are some areas which are known to contain high-pressure gas in considerable quantities. There are numerous sands covered up over this great area which hold both natural gas and petroleum. It is usually the position of the well with reference to the arch which determines whether it will produce gas or petroleum. Since the gas is very much lighter than

petroleum, it is found in the higher portion of the same sand stratum, while the petroleum is contained in the lower portion and salt water in and near the bottom of the trough. There are often exceptions to this, however, which are generally accounted for by local folding or thickening of the strata in the floor of the trough or on the flanks of the uplift.

There are a number of sandstone strata that in different parts of the region produce gas. In a few localities three of the sandstone strata passed through by the drill are known to have produced gas in quantity, but usually the big flow found is confined to a single stratum. The strata which contain gas in quantity in different locations begin with the upper member of the Mahoning or Dunkard sands, at the bottom of the Barren Measures of the Carboniferous group, and end with the Kane sand of the Middle Chemung formation. The whole section represents a distance of about 3,500 feet of vertical strata, in which there are about twenty-five separate producing sands. They vary in structure from a dark-red compact sandstone to sands containing beautifully rounded pebbles from the size of a pea up to a marble. The top portion of the sand is often very hard, compact silica. The open or pebble formation is found below. The sand is usually covered with a compact slate or shale.

A GENERALIZED WELL RECORD.

The following is a well record generalized so as to show the principal gas-producing strata in southern Greene County, Pennsylvania, and Monongalia and Wetzel counties, West Virginia, beginning with the Mapletown or Sewickley coal, which is assumed to be found at a depth of 720 feet.

Formation.	Top.	Bottom.	Remarks.
	Feet.	*Feet.*	
Conductor	0	16	
$13\frac{1}{4}$-inch casing	0	144	
10-inch casing	0	1,148	
$8\frac{1}{4}$-inch casing	0	1,755	
$6\frac{5}{8}$-inch casing	0	1,842	
$5\frac{3}{16}$-inch casing	0	2,204	
$4\frac{1}{4}$-inch liner in cave at 2803	2,803	290	
Sewickley coal	720	725	
Pittsburg coal	815	825	Produces gas in several localities.
Red cave	1,015	1,055	Near crinoidal limestone.

Formation.	Top.	Bottom.	Remarks.
	Feet.	*Feet.*	
Crinoidal sandstone	1,115	1,140	
Upper Dunkard sand	1,220	1,260	Fair gas wells in localities.
Lower Dunkard sand	1,320	1,370	Do.
Gas sand	1,615	1,675	Large gas wells in localities.
Salt sand	1,715	1,842	Do.
Limestone	1,950	1,985	
Pencil cave	1,985	1,990	
Limestone	1,990	2,050	
Big Injun sand	2,050	2,330	Powerful gas wells in localities.
Squaw sand	2,390	2,440	Good gas wells in localities.
Berea sand	2,600	2,635	Large gas wells in localities.
Gantz sand	2,750	2,790	Powerful gas wells in localities.
Fifty-foot sand	2,808	2,845	Do.
Thirty-foot sand	2,880	2,905	Do.
Gordon or third sand	2,950	2,975	Do.
Fourth sand	3,020	3,045	Fair gas wells in localities.
Stray sand	3,090	3,100	Powerful gas wells in localities.
Fifth sand	3,118	3,135	Do.
Bayard or sixth sand	3,225	3,238	Do.

The gas regions in Ohio, known as the Sugar Creek and Lancaster pools, obtain their gas in the Clinton limestone and are considered to belong more closely to the Appalachian gas field than to the Lima-Indiana field.

THE CINCINNATI ARCH.

The natural gas produced in what is known as the Lima-Indiana field comes entirely from the Trenton limestone; not that the limestone in all localities holds the gas, for it is contained only in those parts of the field where natural reservoirs have been formed in the rock. A portion of the limestone areas in Ohio and Indiana has two or more strata near the top of the formation which are more or less porous or cellular, owing to the fact that the interlinking of the crystals of dolomite leave small spaces for the accumulation of the gas. Into these porous divisions, commonly termed "pay streaks," the natural gas has been stored under enormous pressure. There is a covering of compact shale, known as the Utica shale, capping the surface of the Trenton limestone, which has sealed in the accumulated gas.

The great Cincinnati arch, beginning in Tennessee, extends through Kentucky in a general northern direction and crosses the Ohio River a few miles above the city of Cincinnati at an elevation on the crest of its anticlinal of 450 feet. The main crest then swings to the northwest with steadily declining elevation and with wide, gently sloping flanks passes into Indiana. At Hartford City, in Blackford County, its crest is at sea level and is covered by 900 feet of superimposed stratifications and drifts. Very near the center of the north and south line forming the western boundary of Ohio an arm starts off from the main arch above described, pointing northeast, whose crest is subject to some undulations until at Findlay, Ohio, it has an elevation of about 315 feet below sea level at the highest elevation and is here covered by 1,100 feet of strata. At this point this arm forks, one limb pursuing a course nearly north as far as Sylvania on the Michigan border. The main arch continues its general course, reaching Lake Erie near Oak Harbor at an elevation of 725 feet below sea level and covered by 1,350 feet of strata.

On the northern flank of the great broad swell of the main arch in Indiana, as well as along the declining crest of the arch toward the northwest, the great natural-gas producing areas are located, and are estimated to contain 2,000 square miles. The area of gas-producing territory in Ohio is estimated at 500 square miles; that at and near Findlay originally contained 100 square miles.

NATURAL-GAS STATISTICS.

It must be remembered that while the greatest care is exercised in getting returns from all the companies supplying natural gas to consumers and from individuals using natural gas, and while over 95 per cent of all the companies and many individuals have made full and complete returns, there is still a very considerable amount of natural gas that is not accounted for in this report. Large quantities of gas are used by companies and individuals as fuel in the operating of pumps on small oil lines, pumping and drilling wells, the manufacture of lampblack, and for domestic fires for operators and land owners in the section where the wells are located. Natural gas needs no preparation to make it marketable, as does petroleum. This amount has been estimated at from 25 to 30 per cent of the amount actually sold. There is also a large percentage lost, owing to leaks in lines, waste due to drilling oil wells in the gas territory, drips, and the blowing off of wells to exhaust the water that often finds its way into them. This is especially true of southwestern Pennsylvania and West Virginia, where there is at present much new work in progress. It is estimated that the average price of natural gas furnished consumers during 1899 was 18½ cents per 1,000 cubic feet.

There were in use up to the close of 1899, 18,856.8 miles of natural-gas mains of various sizes, from 2 inches up to 36 inches in diameter.

EXHAUSTION OF THE GAS FIELDS.

It is unfortunately true that both of the great gas-producing fields, large as they once were, are approaching exhaustion. The greater portion of the Ohio division of this field, which originally had a rock pressure of 480 pounds to the square inch, has now no rock pressure whatever. A large area of the Indiana division has also yielded up over one-half of the volume of natural gas once stored in its great reservoirs. The original rock pressure in Indiana was the same all over the field, and registered 325 pounds to the square inch; it is now down to an average of 165 pounds to the square inch, and if 100 pounds is required to hold back the pressure of salt water, the figures show that 66 per cent of the product has been taken out and consumed. The unjustifiable waste in all the natural-gas fields has been enormous. Because of the original idea that the gas supply was inexhaustible, since one or two wells did not show any large decline in pressure during the first six months of their lives, and also because it seemed to cost the owners nothing after the well was drilled in, millions and millions of cubic feet of this valuable fuel were allowed to escape into the air unconsumed. Its value will only be realized after it is all exhausted.

All the fields show loss of pressure. The old field of Trenton-rock gas in northwestern Ohio is nearly exhausted. That of Indiana is undergoing a rapid decline. Many of the old fields have been practically exhausted in Pennsylvania also. Were it not for the fact that in Pennsylvania and West Virginia the gas areas are more or less separated by streaks of unproductive territory they too would have shown the same conditions that are observed in Ohio and Indiana. To reach the various gas pools of the Appalachian fields usually involves a complete change in the location of gas mains, which is a source of continual expense to the eastern gas companies. The great broad and almost continuous gas-producing expanse of the Trenton limestone inside of defined limits have, however, made it a matter of simply lengthening the gas mains to reach additional territory. The calorific value of natural gas, its comparative value as used in gas engines, and its illuminating qualities have been fully discussed in previous reports.

VALUE OF NATURAL-GAS PRODUCTION.

In the following table is given the approximate value of natural gas produced in the United States from 1888 to 1899, by States.

Approximate value of natural gas produced in the United States from 1888 to 1899.

State.	1888.	1889.	1890.	1891.	1892.	1893.
Arkansas	....	$375	(a)	$250	$100	$100
California	....	12,680	$33,000	30,000	55,000	62,000
Illinois	....	10,615	6,000	6,000	12,988	14,000
Indiana	$1,320,000	2,075,702	2,302,500	3,942,500	4,716,000	5,718,000
Kansas	....	15,873	12,000	5,500	40,795	50,000
Kentucky	....	2,580	30,000	38,993	43,175	68,500
Missouri	....	35,687	10,500	1,500	3,775	2,100
New York	332,500	530,026	552,000	280,000	216,000	210,000
Ohio	1,500,000	5,215,669	4,684,300	3,076,325	2,136,000	1,510,000
Pennsylvania	19,282,375	11,593,989	9,551,025	7,834,016	7,376,281	6,488,000
South Dakota	....	25	(a)	....	....	....
Texas	....	1,728	(a)	....	100	50
Utah	....	150	(a)	....	....	500
West Virginia	120,000	12,000	5,400	35,000	500	123,000
Other States	75,000	1,600,000	1,600,000	250,000	200,000	100,000
Total	22,629,875	21,107,099	18,792,725	15,500,084	14,800,714	14,346,250

State.	1894.	1895.	1896.	1897.	1898.	1899.
Arkansas	$100	$100	$60	$40	....	....
California	60,350	55,000	55,682	50,000	$65,337	$86,891
Colorado	12,000	7,000	4,500	4,000	3,300	1,480
Illinois	15,000	7,500	6,375	5,000	2,498	2,067
Indiana	5,437,000	5,203,200	*b* 5,043,635	*b* 5,009,208	*c* 5,060,969	*d* 6,680,370
Kansas	86,600	112,400	124,750	105,700	174,640	282,592
Kentucky	89,200	98,700	99,000	90,000	103,133	125,745
Missouri	4,500	3,500	1,500	500	145	290
New York	249,000	241,530	256,000	200,076	229,078	294,593
Ohio	1,276,100	1,255,700	1,172,400	1,171,777	1,488,308	1,866,271
Pennsylvania	6,279,000	5,852,000	*e* 5,528,610	*f* 6,242,543	*g* 6,806,742	*h* 8,337,210
South Dakota	....	....	....	....	....	3,500
Texas	50	20	....	....	765	8,000
Utah	500	20,000	20,000	15,050	7,875	....
West Virginia	395,000	100,000	*i* 640,000	*j* 912,528	*k* 1,334,023	*l* 2,335,864
Other States	50,000	50,000	50,000	20,000	20,000	....
Total	*m* 13,954,400	*m* 13,006,650	*m* 13,002,512	*m* 13,826,422	*m* 15,296,813	*m* 20,024,873

a Total value of gas produced in Arkansas, South Dakota, Texas, and Utah, $6,000.
b Includes value of some gas produced in Indiana but consumed in Ohio and Illinois.
c Includes $1,098,568 worth of gas produced in Indiana but consumed in Ohio and Illinois.
d Includes $1,807,000 worth of gas produced in Indiana but consumed in Ohio and Illinois.
e Includes $912,000 worth of gas produced in Pennsylvania but consumed in New York and Ohio.
f Includes $999,882 worth of gas produced in Pennsylvania but consumed in New York, Ohio, and West Virginia.
g Includes $1,242,265 worth of gas produced in Pennsylvania but consumed in New York, Ohio, and West Virginia.
h Includes $1,404,790 worth of gas produced in Pennsylvania but consumed in New York, Ohio, and West Virginia.
i Includes $126,000 worth of gas produced in West Virginia but consumed in Pennsylvania and Ohio.
j Includes $269,336 worth of gas produced in West Virginia but consumed in Pennsylvania and Ohio.
k Includes $589,438 worth of gas produced in West Virginia but consumed in Pennsylvania and Ohio.
l Includes $1,212,233 worth of gas produced in West Virginia but consumed in Pennsylvania and Ohio.
m Does not include value of gas produced in Canada and consumed in the United States.

In the above table is given the value of the natural gas produced in the different States. Several States produce gas which is consumed in adjoining States. They supply more gas than finds a ready market in the sections readily accessible to the source of production, the pipe line being the medium through which it is conveyed to market.

The following table shows the value of the natural gas consumed in the several States during 1899 and the value of the fuel displaced by it. The gas-producing States are traversed by an intricate system of pipe lines, reaching from one State to two or more others in several instances. Thus, Pennsylvania supplies natural gas to New York, Ohio, and West Virginia. Ohio does not furnish any gas to any of the bordering States, although several years ago it furnished some gas to Michigan. It receives natural gas from Pennsylvania, Indiana, West Virginia, and Kentucky. Indiana furnishes natural gas to Ohio and Illinois. West Virginia furnishes natural gas to Ohio and Pennsylvania and receives natural gas from Pennsylvania and Kentucky. Canada furnishes natural gas to Michigan, New York, and Ohio. So it can readily be seen that the collection and distribution of the statistics of our natural-gas product in the several States requires a large amount of skill and labor.

During the past year there was a consolidation of a number of the companies furnishing natural gas. There was also an increase in the price at which the natural gas was marketed during 1899, as compared with former years. It will be also noticed that 1,428 individuals and companies made returns in 1899, as compared with 1,169 in 1898.

The conspicuous item in the following table is the small amount received in the States of Indiana and Kansas for the natural gas sold, as compared with the value of the fuel displaced.

It is unfortunate that it is not possible to obtain the figures for the amount in cubic feet of gas consumed, instead of the amount received in value and the value of the fuel displaced by it. The average price of fuel in Indiana is not any greater than that of western Pennsylvania, so that these two States may be compared. This shows that Indiana produced more cubic feet of natural gas in 1899 by 25 per cent than Pennsylvania. In Indiana only 45 per cent of the fuel value of the gas was collected in 1899. There were 339 establishments using gas in Indiana in 1899, 63 in Ohio, and 124 in Pennsylvania.

Value of natural gas consumed in the United States in 1899, by States, and the value of coal or wood displaced by same, as reported by 1,428 persons, firms, and corporations.

State.	Companies or individuals reporting.	Amount received for sale of gas or value of gas consumed.	Estimated value of coal, wood, or other fuel displaced by gas.
Pennsylvania	*a* 281	*b* $7,926,970	$7,751,435
Indiana	571	*c* 5,833,370	10,095,994
Ohio	*d* 359	*e* 3,207,286	3,562,763
West Virginia	30	*f* 1,310,675	1,489,421
New York	84	*g* 1,236,007	1,143,977
Kansas	31	282,592	473,381
Kentucky	22	125,745	127,197
California	13	86,891	119,634
Texas	3	8,000	8,000
South Dakota	3	3,500	10,000
Illinois	23	2,067	2,067
Colorado	3	1,480	1,480
Missouri	5	290	290
Total	1,428	*h* 20,024,873	24,785,639

a Includes 82 individual producers, having a total of 117 wells, and consumed gas to the value of $11,119.

b Includes $994,550 worth of gas produced in West Virginia, but consumed in Pennsylvania.

c Includes value of gas consumed in Illinois.

d Includes 278 individual producers, having a total of 318 wells, and consumed gas to the value of $16,258.

e Includes $1,341,015 worth of gas produced in Pennsylvania, Indiana, and West Virginia, but consumed in Ohio.

f Includes $150,000 worth of gas produced in Pennsylvania, but consumed in West Virginia.

g Includes $941,414 worth of gas produced in Pennsylvania, but consumed in New York.

h Does not include gas produced in Canada and consumed in Buffalo, Detroit, and Toledo.

The following table shows the various uses to which natural gas is applied as fuel in whole or in part.

For the manufacture of glass, in the puddling of iron, the heating of large furnaces in the manufacture of steel, roasting ores, and many metallurgical operations natural gas is without a rival. The gaseous state of fuel is the final step towards combustion, since all solid and liquid fuel must be converted into a gaseous condition before it is con-consumed. This accounts for the extra work accomplished with gas as a fuel. It has a heating value greater by one-third than the best coal gas, is doubly as effective as carbureted water gas, three and one-half times as effective as uncarbureted water gas, and seven and one-half times as effective as ordinary producer gas. The proper consumption of this fuel is in the domestic fires, however, for which it is so eminently fitted and to which it naturally belongs. It supplies over 630,000 domestic fires, used by 3,000,000 people, and furnishes light for 4,000,000 human beings.

Uses to which natural gas produced in the United States in 1899 was put, as reported by 1,428 persons, firms, and corporations.

State.	Companies or individuals reporting.	Domestic fires supplied.	Establishments supplied.				
			Iron mills.	Steel works.	Glass works.	Other establishments.	Total.
Pennsylvania	281	232,060	....	*a* 50	75	1,111	1,236
Indiana	571	181,440	10	2	93	1,636	1,741
Ohio	359	77,787	....	8	12	671	691
West Virginia	30	38,137	1	3	14	287	305
New York	84	76,544	....	....	2	119	121
Kansas	31	10,071	2	....	....	69	71
Kentucky	22	12,782	....	....	....	23	23
California	13	1,105	....	....	....	7	7
Texas	3	85	....	....	....	21	21
South Dakota	3	(*b*)	....	....	....	1	1
Illinois	23	105	....	....	....	2	2
Colorado	3	53	....	....	....	....	....
Missouri	5	17	....	....	....	....	....
Total	1,428	630,186	13	*c* 63	196	3,947	4,219

a Includes iron mills. *b* Could not be ascertained. *c* Includes iron mills in Pennsylvania.

DETAILED STATEMENTS OF COMPANIES MAKING COMPLETE RETURNS.

The following table is interesting because all the companies and individuals of the various States made complete returns. By comparing the amounts received for sale of gas in this table with the value of the gas consumed in the States named, reported in a former table, it will be seen that these returns are quite full, especially so in the case of Indiana. The business of the same number of companies in Pennsylvania, Indiana, and Ohio for 1898 and 1899 is shown and the value of the fuel displaced is compared. In Pennsylvania there is only a slight difference in the value of the gas and the value of the fuel displaced. In Indiana the value of the other fuel displaced is nearly double that of the gas sold or used, showing very cheap gas. In Ohio the value of the coal or wood displaced in 1899 was 13 per cent greater than the cost of gas. This table is very complete and is worthy of careful study and comparison.

Natural gas records in 1898 and 1899.

	Pennsylvania.		Indiana.		Ohio.	
	1898.	1899.	1898.	1899.	1898.	1899.
Amount received for sale of gas or value of gas consumed	$5,492,901	$6,362,360	$3,397,580	$3,427,461	$1,967,313	$2,377,334
Value of coal or wood displaced	$5,411,953	$6,134,007	$5,783,842	$6,579,348	$1,921,741	$2,692,888
Domestic fires supplied	209,890	215,518	154,248	151,080	61,845	56,455
Iron and steel works supplied	36	46	7	6	0	6
Glassworks supplied	49	56	45	41	9	8
Other establishments supplied	859	999	1,557	1,454	247	387
Total establishments supplied	944	1,101	1,609	1,501	256	401
Total wells producing Jan. 1	1,930	2,101	2,104	2,402	492	504
Total producing wells drilled	266	382	482	537	78	94
Total wells abandoned	95	143	184	314	66	106
Total wells producing Dec. 31	2,101	2,340	2,402	2,625	504	492
Total dry holes drilled	61	78	77	77	10	14
Total feet of pipe laid	29,206,344	30,059,489	21,084,973	20,902,794	10,084,070	11,061,329
Total establishments reporting	124	124	339	339	63	63

RECORD OF WELLS AND PIPELINES, BY STATES.

In the following table will be found the number of companies and individuals reporting, the producing wells at the close of 1898 and 1899, the producing wells drilled, and the nonproducing or dry holes drilled in 1899, together with the total feet of pipe in use at the close of 1899:

Record of wells and amount of pipe line, as reported by 1,428 persons, firms, and corporations in 1899.

State.	Companies or individuals reporting.	Wells.					Total pipe laid to Dec. 31, 1899.	
		Producing, Dec. 31, 1898.	Producing, drilled in 1899.	Abandoned in 1899.	Producing, Dec. 31, 1899.	Nonproducing holes drilled in 1899.	Feet.	Miles.
Pennsylvania	281	*a* 3,008	467	172	*a* 3,303	104	36,778,526	6,965.6
Indiana	571	3,473	838	402	3,909	109	31,758,296	6,014.8
Ohio	359	*b* 916	134	121	*b* 929	17	14,618,624	2,768.7
West Virginia	30	269	78	9	*c* 338	6	8,692,320	1,646.3
New York	84	476	36	12	500	7	5,500,990	1,041.9
Kansas	31	144	44	8	*d* 180	22	1,392,403	263.7
Kentucky	22	86	9	5	90	3	620,402	117.5
California	13	23	1	4	20	0	124,190	23.5
Texas	3	5	9	2	12	0	35,000	6.6
South Dakota	3	3	1	0	4	0	(*e*)	(*e*)
Illinois	23	33	7	9	31	7	30,000	5.7
Colorado	3	12	0	0	12	0	12,000	2.3
Missouri	5	5	0	0	5	0	1,200	.2
Total	1,428	8,453	1,624	744	9,333	275	99,563,951	18,856.8

a In addition 26 wells were shut in; not used in 1899.
b In addition 7 wells were shut in; not used in 1899.
c Includes 1 well which was shut in at close of 1899.
d Includes 20 not used at close of 1899; shut in.
e Not known.

RECORDS BY STATES.

PENNSYLVANIA.

The most important event in connection with natural-gas production in Pennsylvania during 1899 was the opening up of a large gas pool in the southern central portion of Greene County, in a deep sand called the "Bayard sand." It was first discovered in this region in a well drilled on the Bayard farm in 1895. From this farm it has been traced over a large area and has produced a number of natural-gas wells with large volume and of a rock pressure originally going up to 850 pounds to the square inch. The Bayard sand is found 110 feet below the top of the "Fifth sand" and nearly 2,400 feet below the Pittsburg coal bed. The general section given in the first portion of this report

shows the relative position of all the sands known to produce gas in this region. There was also a number of good gas wells found on the southern border of the Gaines oil field in Tioga County.

There is a continuous chain of counties in Western Pennsylvania in which natural gas is found, extending from the northern limit to the southern limit in the following order: Tioga, Potter, McKean, Warren, Elk, Forest, Venango, Jefferson, Clarion, Indiana, Armstrong, Butler, Westmoreland, Allegheny, Beaver, Washington, Greene, and Fayette. Gas is likewise found in Erie, Crawford, Lawrence, and Mercer counties, but in smaller amounts.

A large portion of the natural gas produced in McKean, Warren, and Potter counties is piped into the State of New York and there consumed. Allegheny and Washington counties furnish some natural gas to Ohio, and Greene County furnishes some natural gas that is consumed in West Virginia. West Virginia furnishes a large amount of natural gas that is consumed in Pennsylvania, estimated to have a value of $994,550, which is credited to the value of the production of West Virginia. There were three items that increased the value of natural gas consumed in Pennsylvania in 1899—there was an increase in price, more complete returns were secured, and there was a larger production.

Many of the old fields that were so prominent twelve years ago are almost completely exhausted, and while the production for 1899 was considerably increased over that of 1898, it was less than one-half of the value of natural gas produced in 1888.

The following table shows that the lowest value of natural gas was in 1896. Since then there has been an increase in value for the three years following.

Value of natural gas produced in Pennsylvania from 1885 to 1899.

Year.	Value.	Year.	Value.
1885	$4,500,000	1893	$6,488,000
1886	9,000,000	1894	6,279,000
1887	13,749,500	1895	5,852,000
1888	19,282,375	1896	5,528,610
1889	11,593,989	1897	6,242,543
1890	9,551,025	1898	6,806,742
1891	7,834,016	1899	8,337,210
1892	7,376,281		

The number of producing wells, as reported, in use at the close of 1899 was 3,303, of which 26 wells were shut in, as compared with 3,008 producing wells at the close of 1898. There were 467 producing wells drilled in 1899 and 104 that were dry. There were 172 gas wells aban-

doned in 1899. There were 440 miles of pipe, 2 inches in diameter and over, laid during 1899 in the different fields and towns. Pennsylvania had a total of 6,965.6 miles of natural-gas mains in use at the close of 1899. Indiana follows close, with 6,014.8 miles in use.

INDIANA.

Indiana produced more gas than any other State in 1899, although the value does not show it, as the price at which it was sold was far below that of any other State (as shown in a former part of this report), and a large amount was sold at prices based upon the size of the fuel orifice instead of the cubic foot consumed as registered by the meter. The former method is extravagant and wrong in principle, as experience has shown that fully double the amount of gas is consumed where the rate is based on the size of the orifice that is consumed where the meter is used and the necessary gas-saving appliances installed, to produce the same heat effects. The drain on this great field, that has been estimated to cover an area of 2,000 square miles, is being felt severely in some of the older sections. The original rock pressure in 1886 was 325 pounds to the square inch; in 1896 it had fallen to an average of 220 pounds; in 1897 to 195 pounds; in 1898 to 165 pounds, and in 1899 the average pressure is estimated as close to 150 pounds. There is an area of some 125 square miles, covering portions of Grant, Blackford, Madison, and Delaware counties, which has not yet been subject to great drainage, where there is still a rock pressure of over 200 pounds to the square inch.

The State of Indiana has passed a law stopping the waste of natural gas by companies in search of petroleum, which has saved many millions of cubic feet of natural gas that would have been wasted. Mr. J. C. Leach, State gas supervisor, in his report to the State geologist, W. S. Blatchley, for 1899, says:

> Practically all the territory in the field is either under lease or is controlled by territory that is leased. More lines have been laid and wells drilled during the year 1899 than in any year previous. The tendency is to enlarge the main supply lines, parallel field lines, and more completely occupy the territory. Most of the wells drilled during the past year show salt water. Five new compressing or pumping stations have been built since the last report and the capacity of five has been increased, making nineteen stations in the field.

Mr. Leach further says:

> While an occasional "gusher" has been reported during the past year, the records of over 300 wells, old and new, show a decline in the volume of flow. The average rock pressure of all that part of the north section, except the outer zone, is 155 pounds. The rock pressure in the undeveloped part of this section (100 square miles) varies from 170 to 210 pounds.
>
> There has not been a well drilled for oil in Madison or Delaware counties for nearly two years. I have closed nine wells during the past year, all of which was by injunction.

There is much anxiety on the part of the residents of the gas belt regarding the future of the manufacturing industry. Though conditions to a certain extent warrant this, I believe that a majority of the factories will successfully adopt other fuels when it becomes necessary. Manufacturers are disposed to find another fuel rather than a new location.

In the following table will be found a statement of the value of the natural gas produced in Indiana from 1886 to 1899:

Value of natural gas produced in Indiana from 1886 to 1899.

Year.	Value.	Year.	Value.
1886	$300,000	1893	$5,718,000
1887	600,000	1894	5,437,000
1888	1,320,000	1895	5,203,200
1889	2,075,702	1896	5,043,635
1890	2,302,500	1897	5,009,208
1891	3,942,500	1898	5,060,969
1892	4,716,000	1899	6,680,370

At the close of 1899 there were 3,909 wells producing natural gas; there were 838 wells drilled in 1899 that were gas producers and 109 that were nonproducers. There were 402 wells abandoned that had been producers. At the close of 1898 there were 3,008 wells producing as reported by the 571 companies and individuals. There were 6,014.8 miles of gas mains 2 inches in diameter and larger in use. The value of natural gas consumed in Indiana during 1899 was $3,427,461; the value of the gas produced was $6,680,370.

WEST VIRGINIA.

This State has increased the value of the output of natural gas in 1899 more than any other. The increase amounted to $1,001,841, equal to 75 per cent.

Most of the gas produced comes from Wetzel County, in the deep sand, including the Big Injun and those below in the following order: Squaw, Gantz, Fiftyfoot, Thirtyfoot, Gordon Stray, Gordon, Fourth, Fifth, Bayard, and Elizabeth sands. In some of the deep wells three sands may be productive, but generally one sand furnishes the main supply. The gas-producing areas usually follow the northeast and southwest directions, parallel to the lines of elevation of the strata, in some cases on the very crest of the folds, in other cases on the flank of the slopes; then again they are found on the minor folds of slight elevation, in the very trough of the basins, or the lower portion of the strata.

There are several instances where gas areas are found at the terminals of the lines of depression, where the whole bottom of the basin

rises up and thereby forms a cross arch. Central Wetzel and eastern Tyler counties are in the deepest portions of the Appalachian Basin, next to that east of Parkersburg, and the lower gas sands are generally covered by from 2,750 to 3,000 feet of strata. The rock pressure in numerous instances is 1,200 pounds to the square inch, when first drilled in, and the volume ranges from 10,000,000 to 18,000,000 cubic feet in twenty-four hours.

Toward the later part of 1899 several large gas wells were found in Lewis and Harrison counties, on the Chestnut Ridge and the Wilsonburg arches.

The counties furnishing natural gas in West Virginia are named in the order of their importance as follows: Wetzel, Tyler, Marion, Monongalia, Ritchie, Harrison, Doddridge, Marshall, Pleasants, Wood, Lewis, Wirt, Roane, Mingo, Kanawha, Calhoun, Logan, and Gilmer.

There is every indication that West Virginia will be called upon to make good the failing natural-gas fields in Pennsylvania and Ohio and that year after year the requirements for these two States must be supplied from the "Mountain State."

The large companies that get their entire supply from this State and carry it into other States are the Hope Natural Gas Company, the Tri-State Natural Gas Company, and the River Natural Gas Company. Those which get a partial supply are the Philadelphia Natural Gas Company, the Carnegie Natural Gas Company, the Wheeling Natural Gas Company, and the West Virginia Natural Gas Company.

Value of natural gas produced in West Virginia from 1889 to 1899.

Year.	Value.	Year.	Value.
1889	$12,000	1895	$100,000
1890	5,400	1896	640,000
1891	35,000	1897	912,528
1892	500	1898	1,334,023
1893	123,000	1899	2,335,864
1894	395,000		

Owing to the active development of the petroleum fields of this State, and the numerous small villages supplied with gas by local operators, scattered through the producing regions, it is safe to say that at least 30 per cent should be added to the valuation above given.

This is the case in all of the States producing gas, but 25 per cent is considered sufficient to cover this item in the other instances.

The number of gas wells as reported by 30 companies at the close of 1899 was 338, as compared with 269 in 1898; 78 producing wells and 6 dry holes were drilled, and 9 old wells abandoned in 1899.

In oil region phraseology, the term "drilled in" is common. A well is not completed until drilled "through the sand," or until the drill is stopped.

OHIO.

The value of the natural gas produced in the State of Ohio in 1899 was $1,866,271, an increase of $377,963 over that of 1898. The decline in the Findlay field (which formerly supplied Toledo) during the year 1899 has been great, as many wells have been drawn upon by the gas compressors until the average pressure is down to that of the atmosphere or below. The most recent development in Ohio is the extension of the old Lancaster field to the south. This district, now known as the Sugar Grove field, has more than offset the decline in the older fields, and added a handsome increase to the total value of the Ohio gas as compared with 1898. A new 10-inch pipe line was laid during the summer and fall of 1899 a distance of 110 miles, connecting the Sugar Grove gas field with the lines that formerly supplied Toledo from the Findlay field.

During the latter part of 1898 a 10-inch main line was constructed from the large gas field in Wetzel County, West Virginia, to the city of Akron and a number of smaller plants in northeastern Ohio. This line crosses the Ohio River just below Moundsville, West Virginia.

During the year 1899, by careful estimate, the value of natural gas consumed in Ohio that was furnished by Indiana, West Virginia, Pennsylvania, and Canada amounted to $511,063.

Prof. Edward Orton, deceased, recently made the following statements in regard to the exhaustion of the northwestern Ohio natural gas fields:

While natural gas discoveries had, of course, been made prior to 1884, yet it was not until that year that it came largely into commercial use. The Findlay well was struck in November, 1884, and for the next few years manufactures of all kinds sprang up in the vicinity. The pressure of the gas was regularly about 400 pounds per square inch, but has been diminishing gradually every year until now the end of the natural flow is approaching. The Findlay field comprised about 125 square miles, but the use of the gas has been so wasteful, so foolishly extravagant, that what was once sufficient for many years has now become small by degrees and ominously less. There is a fine field west of Findlay, in Auglaize, Allen, and Mercer counties. From fields supplying Toledo there has been such a lack of gas that it is now piped from Canada. In northwestern Ohio generally there has been a diminishing pressure for sometime past. The great Karg well at Findlay, opened in 1886, gave 14,000,000 cubic feet of gas in twenty-four hours. It was wasted for months, something like a billion feet being burned in the air, and it was thought by some persons that the supply was inexhaustible. The Fairmount well, in Indiana, yielded about 11,000,000 feet a day, but it also was wasted.

The value of the natural gas produced (not consumed) is shown in the following table, from 1885 to 1899, by years:

Value of natural gas produced in Ohio from 1885 to 1899.

Year.	Value.	Year.	Value.
1885	$100,000	1893	$1,510,000
1886	400,000	1894	1,276,100
1887	1,000,000	1895	1,255,700
1888	1,500,000	1896	1,172,400
1889	5,215,669	1897	1,171,777
1890	4,684,300	1898	1,488,308
1891	3,076,325	1899	1,866,271
1892	2,136,000		

The value of natural gas consumed in Ohio during 1899 was $2,377,334. Of this amount $511,063 worth of natural gas was supplied by Indiana, Ohio, and Pennsylvania. The total number of wells reported producing at the beginning of 1899 was 916 as compared with 929 at the close of the year. There were 134 producing wells found, 17 nonproducing, and 121 wells abandoned in 1899.

NEW YORK.

There is a large area of gas-producing territory in the western and central portions of this State in strata beginning with the black Devonian shale and extending down to the Potsdam. Although the wells are generally light in pressure, many have considerable volume. The counties producing natural gas are Allegany, Cattaraugus, Chautauqua, Erie, Livingston, Niagara, Onondaga, Ontario, Oswego, Seneca, and Steuben. By far the greater portion furnished by the State comes from the neighborhood of Wellsville and Ricebrook, in Allegany County. These wells are found skirting the oil-producing region and are gradually decreasing in volume and pressure.

A large number of these wells are connected, reinforced by a few scattering wells, supplying the towns of Friendship, Nile, Belmont, Andover, Cuba, Ceres, Wellsville, Scio, Stanards Corners, Allentown, Bolivar, Richburg, Olean (in part), Willing, and Independence, wholly or in part. Buffalo receives the greater part of its gas supply from Pennsylvania, with some from Erie County, New York, and from Canada. Jamestown and Salamanca receive their gas from Pennsylvania, and Olean also receives nearly all of its gas from that State.

The towns of Ripley and Maysville are supplied with gas from wells in Chautauqua County. There are many small wells that produce gas at moderate depths in the black shale that supply many individual families with light and heat.

Clarence, Depew, Alden, East Aurora, Orchard Park, North Tonawanda, and a small part of Buffalo are supplied by wells in Erie County that are about 950 feet in depth. The gas is found in the red Medina sandstone, and the pressure is holding up well. The gas wells in Livingston County also get their supply from the same rock at about 1,100 feet in depth. The present pressure is 200 pounds to the square inch, as compared with 400 pounds when first tapped. These wells supply Caledonia. Baldwinsville is supplied from wells in Onondaga County, where the top of the Trenton limestone is reached at 2,250 feet, and at 120 feet in the rock a vein of gas showing 1,525 pounds pressure to the square inch was struck, but soon decreased.

Honeoye Falls, North and West Bloomfield receive gas from Ontario County which formerly came from the black shale, but latterly a better supply is found in the Medina sandstone. Pulaski, Sandy Creek, and Lacona all get gas from Oswego County from the bottom of the Trenton limestone, where it is found in pockets with high rock pressure, but lacking in volume or storage capacity.

The value of natural gas produced in New York from 1885 to 1899, is given in the following table:

Value of natural gas produced in New York from 1885 to 1899.

Year.	Value.	Year.	Value.
1885	$196,000	1893	$210,000
1886	210,000	1894	249,000
1887	333,000	1895	241,530
1888	332,500	1896	[a] 256,000
1889	530,026	1897	200,076
1890	552,000	1898	229,078
1891	280,000	1899	294,593
1892	216,000		

[a] A portion of this amount should be credited to Pennsylvania, but it was impossible to make the separation.

There were 500 gas wells in use in this State at the close of 1899 as compared with 476 in 1898. There were 36 drilled that produced gas in paying quantities, there were 7 drilled that were dry, and 12 abandoned in 1899.

The first use of natural gas in the United States was at Fredonia, New York, about the year 1821. The following interesting account of its early application is taken from a letter to Mr. Melvin H. Taylor, of Fredonia, New York, from Mr. Franklin Burritt:

> The history of the natural gas of this village discloses the following facts: About 1821 the early settlers were moved to make experiments to ascertain its character

and illuminating power. It was introduced into the old Abell tavern, which then occupied the site of the Hotel Columbia, and also into a few of the shops and stores of the village. The Abell tavern was lighted by this gas when General Lafayette, in 1825, visited this village. This gas thus used at that time was the first employed in the United States for that purpose.

The spring first discovered, and from which gas was taken, is located on the north bank of Canadaway Creek, near the bridge crossing the stream at the foot of Main street, within a few rods of the McClure or Tefft mill. The gas escaped at various places in that vicinity. Jesse Starr sank a well into which the gas was drawn. Mr. Starr built a gasometer as a gas receiver. He piped Main street with lead pipe and the shops and stores on that street used the gas to light their places. The price charged therefor was $3 a year. This primitive gas arrangement was used alone until about 1858. About that time another gas well was sunk farther down the creek by Preston Barmore. Soon thereafter Elias Forbes bought a half interest in the well and formed a company. The well was ample to supply 2,000 cubic feet a day. It was conducted to the village through 3 miles of iron mains. The gas was supplied directly from the well to the stores and public buildings. In 1859 the company put in a gas receiver of 1,200 cubic feet capacity and supplied private houses. In 1871 Ahab Colburn bought the Barmore interest in the gas company and made a boring for gas near his mill, with a view to supply fuel for generating steam therefor. The supply was inadequate and he connected his well, which was 1,200 feet deep, with the Barmore receiver. The supply of gas by that arrangement proved ample for the supply of the village for many years. When a deficiency occurred the shortage was made up by gas manufactured from coal.

KANSAS.

The value of the output from this State is gradually increasing. Gas is produced in a commercial way in Allen, Labette, Montgomery, Miami, and Wilson counties. A few good wells were also found in Franklin County, but are not yet utilized. Some drilling has been done in Crawford County, but with poor success. Several other counties have small flows of gas from individual wells. There is much to indicate that many other pools will be found in the future.

The usual depth of the wells is from 900 to 1,150 feet. The rock pressure varies from 300 to 325 pounds to the square inch. The volume of some of the best wells was from 6,000,000 to 8,000,000 cubic feet in twenty-four hours. The largest and best wells get their gas in a porous brown sand 15 to 20 feet in thickness (not unlike the Bradford sand in color and texture), which is found near the bottom of the Cherokee shale and about 40 to 60 feet above the top of the Mississippian limestone. There seems to be a series of gentle elevations and depressions in the floor of this limestone and sandstone. Gas is found in the higher portions and oil is found in the troughs. This is notably the case at Neodesha.

It is used in nearly all of the towns in southeastern Kansas for domestic and manufacturing purposes. So far the wells have shown but slight reduction in the original pressure. The gas from the Iola field is used extensively in the reduction of the zinc ores raised at Joplin, Missouri, with great success. Six large reduction works are established at that place.

The value of the natural gas produced in Kansas from 1889 to 1899 has been as follows:

Value of natural gas produced in Kansas from 1889 to 1899.

Year.	Value.	Year.	Value.
1889	$15,873	1895	$112,400
1890	12,000	1896	124,750
1891	5,500	1897	105,700
1892	40,795	1898	174,640
1893	50,000	1899	282,592
1894	86,600		

KENTUCKY.

There are a number of good gas wells in Martin County, Kentucky, that have a volume of from 8,000,000 to 10,000,000 cubic feet per day. The gas comes from the salt sand above the "big lime," the "Big Injun" below the "big lime," and the Berea sands. There is some gas found in Floyd County near the oil field on Right Beaver Creek. There is considerable gas produced in Meade County that is piped to Louisville.

The Triple State Oil and Gas Company lately connected their wells in Martin County with Louisa, Catlettsburg, and Ashland, Kentucky, and Ironton, Ohio. It has also extended its lines to Ceredo, Kenova, and Huntington, West Virginia, although it was nearly the close of the year 1899 before their sales were of much magnitude. There is also some gas produced in Wayne and Barren counties.

Value of natural gas produced in Kentucky from 1889 to 1899.

Year.	Value.	Year.	Value.
1889	$2,580	1895	$98,700
1890	30,000	1896	99,000
1891	38,993	1897	90,000
1892	43,175	1898	103,133
1893	68,500	1899	125,745
1894	89,200		

At the close of 1899 there were 90 producing wells in the State, as compared with 86 in 1898. In 1899 there were 9 producing wells drilled, 5 were abandoned, and 3 were dry.

CALIFORNIA.

There are many wells producing a small amount of gas scattered in the Sacramento and San Joaquin valleys of California. There are also numerous springs through this region in which gas is found bubbling up with the water. The range of these springs in some localities is northwesterly to southeasterly and may mark the line of an old earthquake fracture. The more or less violent folding of the strata in most of this region, together with earthquakes of varying severity, has prevented the accumulation of large reservoirs of high-pressure natural gas throughout these valleys. There may be large reservoirs in the probable anticlinals buried under the mass of alluvium that is found.

At Stockton, in the San Joaquin Valley, where nearly all of the natural gas utilized is produced, 25 wells have been sunk. The wells usually range from 1,000 to 1,400 feet in depth. One of them (an exception to the rule) is 2,500 feet in depth, furnishing gas sufficient to supply a number of families with heat and light. Most of these wells flow gas and water together, and furnish from 20,000 to 50,000 cubic feet per day. The pressure varies from 3.3 inches to 6.8 inches of water. Its fuel value, as compared with that of coke and of Nanaimo coal, showed as follows: 2,000 pounds of coke, carrying 10 per cent ash, equals 42,500 cubic feet of gas; 2,000 pounds of Nanaimo coal equals 38,000 cubic feet of gas. This is considerably below that of the gas of the Eastern fields, and is due to a larger percentage of nitrogen in the natural gas of California.

There are numerous wells which furnish from 1,000 to 20,000 cubic feet, usually associated with flowing water, in Merced, Tulare, and Fresno counties. At Los Angeles there are some wells that flow moderate quantities of gas in the locality of the oil wells, the gas from which is used for generating steam and for domestic purposes.

The production of natural gas in California from 1889 to 1899 was valued as follows, the year 1899 showing the largest value of any single year:

Value of natural gas produced in California from 1889 to 1899.

Year.	Value.	Year.	Value.
1889	$12,680	1895	$55,000
1890	33,000	1896	55,682
1891	30,000	1897	50,000
1892	55,000	1898	65,337
1893	62,000	1899	86,891
1894	60,350		

ILLINOIS.

Natural gas is found in Bureau and Randolph counties. In Bureau County the pressure remains steady from 3 to 30 pounds, and the average depth is about 140 to 160 feet. The gas is found in a green sand capped by a hard blue clay. It is used for domestic purposes, and a large number of families have their own gas wells. The supply has been steadily maintained for ten years. In Randolph County there are a number of gas wells (in the town of Sparta) that have furnished a constant supply of gas for eight years, but which are now nearly exhausted.

The production of natural gas in Illinois from 1889 to 1899 was valued as follows:

Value of natural gas produced in Illinois from 1889 to 1899.

Year.	Value.	Year.	Value.
1889	$10,615	1895	$7,500
1890	6,000	1896	6,375
1891	6,000	1897	5,000
1892	12,988	1898	2,498
1893	14,000	1899	2,067
1894	15,000		

TEXAS.

Toward the close of 1899 two separate companies at Corsicana began to make use of the natural gas heretofore neglected in this section, but up to the close of the year no large amount has been supplied by either. There are a number of wells in the Corsicana field that produce gas in paying quantities.

There is also a small well in Baxter County that has been producing gas for several years.

UTAH.

Utah's production of natural gas appears to have ceased entirely during 1899. Great difficulty has been experienced in keeping the wells free from the slate which, falling from the sides of the holes, gradually closes them up, so that the flow of gas becomes too small to be utilized. The gas wells of Utah are located on the shore of Salt Lake, 12 miles north of Salt Lake City.

The value of natural gas produced in Utah from 1893 to 1899 has been as follows:

Value of natural gas produced in Utah from 1893 to 1899.

Year.	Value.	Year.	Value.
1893	$500	1897	$15,050
1894	500	1898	7,875
1895	20,000	1899	0
1896	20,000		

SOUTH DAKOTA.

For the first time in many years South Dakota is given as a gas-producing State. The gas is produced from artesian wells, of which there are four located in the city of Pierre, Hughes County, the fourth well having been completed in 1899. The first well was drilled in 1892, and there is no apparent diminution of the gas. The gas is found at various intervals from a depth of 500 to 1,500 feet. The water comes from sand rock, which lies beneath shale and on top of granite. The greatest flow is apparently found with the artesian water in the rock at a depth of 1,200 to 1,500 feet. The gas is a marsh gas, and there are no signs of petroleum. The gas is used in the city of Pierre for cooking purposes by a number of families, but not for heating, as there is no pressure from the wells. It is also used quite extensively for illuminating and for motive power. The flame is blue and gives scarcely any light unless used with incandescent mantles. The wells seem to be growing better all the time and furnish about 30,000 feet of gas per day.

CANADA.

There are two fields in Ontario that produce nearly all the natural gas found in Canada. The larger is the Essex field, in the southeastern portion of the county of Essex, on the lake front, not far from Peelee Point. The other is the Welland field, near Buffalo, New York.

The Essex field furnishes two-thirds of the output of Ontario, Canada. There are 45 producing wells in this district, drilled to about 1,000 feet in depth, which supply the towns of Leamington, Kingsville, Windsor, and Walkersville, Ontario. A large portion is carried across the river and sold in Detroit to the Detroit City Gas Company. A portion of it was delivered to Toledo, Ohio, and sold there. It is very remarkable how long this small gas field, which was opened up in 1891, has kept up its supply. The rock pressure was originally 400 pounds and is now 300 pounds to the square inch.

The Welland gas field is also on the lake front, in Welland County, near the western extremity of Lake Erie. There are about 80 producing wells in this district, drilled to a depth of from 830 to 850 feet. The rock pressure averages 200 pounds to the square inch and is found in the Medina sandstone. This field furnishes the remaining one-third of the output of Canada. There is a small amount of natural gas used in and around Petrolea and Sarnia. The following table, showing the value of the natural gas at the wells in Canada, is taken from the Annual Report of Mineral Statistics and Mines, Ottawa, Canada:

Value of natural gas produced in Canada from 1892 to 1899.

Year.	Value.	Year.	Value.
1892	$150,000	1896	$364,156
1893	366,233	1897	325,873
1894	313,754	1898	364,699
1895	423,032	1899	387,271

Most of this gas was transported by pipe lines and marketed at Detroit, Michigan; Buffalo, New York, and Toledo, Ohio, where its value for the year 1899, was $612,357.

The following table, furnished by the Bureau of Mines, Toronto, shows the number of producing wells, miles of pipe, workmen employed, value of the gas product at the point of production, and the wages for labor:

Statistics of natural gas production in the Province of Ontario, Canada.

Year.	Producing wells.	Miles of gas pipe.	Workmen employed.	Value of gas product.	Wages for labor.
1893	107	117	59	$238,200	$24,592
1894	110	183½	99	204,179	53,130
1895	123	248	92	282,986	73,328
1896	141	287¼	87	276,710	47,527
1897	140	297	84	308,448	42,338
1898	142	315¼	85	301,599	31,457
1899	150	341½	95	440,904	40,149

The number of producing gas wells bored in the year 1899 was 28, while the number of dry holes was 7.

IMPORTS.

In the following table will be found a statement of the value of the natural gas imported into the United States from 1891, when it was first enumerated, as assigned by the United States custom-house:

Value of natural gas imported into the United States from 1891 to 1899.

Calendar year.	Value.	Calendar year.	Value.
1891 (latter half)	$25,540	1896	$87,446
1892	74,737	1897	80,607
1893	90,653	1898	95,527
1894	62,253	1899	121,311
1895	89,419		

ASPHALTUM AND BITUMINOUS ROCK.

By Edward W. Parker.

PRODUCTION.

In the preparation of these reports the numerous varieties of bitumens or hydrocarbons occurring in the United States and not discussed in the chapter on petroleum are included under the general head of asphaltum. It has been found advisable, however, to make a distinction, for trade purposes, between the purer forms of hard and soft asphaltum, such as elaterite, gilsonite, albertite, maltha, brea, etc., and the sandstones and limestones impregnated with bitumen and known as bituminous or asphaltic limestone, bituminous sandstone, etc. The latter are usually shipped without being previously treated or refined, are used principally for street paving, and are manipulated and mixed with the other ingredients at the place where they are to be used. This class of bitumens is known to the trade, particularly in California, which yields about 90 per cent of the product, as bituminous rock, and it is so considered in this report. In some cases the asphaltum or bitumen is extracted from the bituminous rock and sold as refined or gum.

The following table shows the annual production of asphaltum and bituminous rock in the United States since 1882:

Production of asphaltum and bituminous rock from 1882 to 1899.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	3,000	$10,500	1891	45,054	$242,264
1883	3,000	10,500	1892	87,680	445,375
1884	3,000	10,500	1893	47,779	372,232
1885	3,000	10,500	1894	60,570	353,400
1886	3,500	14,000	1895	68,163	348,281
1887	4,000	16,000	1896	80,503	577,563
1888	50,450	187,500	1897	75,945	664,632
1889	51,735	171,537	1898	76,337	675,649
1890	40,841	190,416	1899	75,085	553,904

As will be seen from the foregoing table, there was a slight decrease in the total amount produced in 1899 compared with the preceding year and a decided falling off in value. The comparatively large

decline in value was due to a marked decrease in the output of maltha or liquid asphaltum in California. In 1898 the total product of liquid asphaltum was reported at 12,875 short tons, valued at $271,000, whereas is 1899 the product reported dropped to 700 short tons, having a value of $9,651. Crude asphaltum (excluding gilsonite and varieties of a similarly pure nature) exhibited a slight decrease in product (406 tons), but with an increase in value of $47,580. The production of bituminous sandstone fell off slightly, both in tonnage and value—not enough to materially affect the total. The output of bituminous limestone and of hard and refined gum each showed substantial increases, both in the amount and value of the product. No sales of mastic were reported in 1899, the material that went into it being reported before treatment and included in the output of bituminous sandstone.

The following table exhibits the production and value of the several kinds of asphaltum and asphaltum products in 1896, 1897, 1898, and 1899. Both the amounts and value are for the product in the condition in which it was first sold.

Varieties of asphaltum, etc., produced in 1896, 1897, 1898, and 1899.

Variety.	1896.		1897.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
Crude asphaltum	6,500	$78,000	5,971	$71,404
Bituminous sandstone	56,971	170,913	48,801	158,914
Bituminous limestone (*a*)	4,300	21,500	2,100	10,600
Mastic	100	900	483	9,864
Hard and refined or gum (*b*)	3,122	92,240	3,940	102,500
Liquid or maltha	9,510	214,010	14,650	311,350
Total	80,503	577,563	75,945	664,632

Variety.	1898.		1899.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
Crude asphaltum	11,300	$179,900	10,894	$227,480
Bituminous sandstone	43,624	126,831	43,041	121,023
Bituminous limestone (*a*)	5,502	26,412	15,650	79,500
Mastic	1,158	17,840	....	....
Hard and refined or gum (*b*)	1,878	53,666	4,800	116,250
Liquid or maltha	12,875	271,000	700	9,651
Total	76,337	675,649	75,085	553,904

a Not including mastic or refined asphaltum made from bituminous limestone.
b Including gilsonite from Colorado and Utah and Ventura from California.

PRODUCTION BY STATES.

Five States and one Territory contributed to the asphaltum production in 1899. These were California, Colorado, Kentucky, Texas, Utah, and the Indian Territory. The production in 1898 was obtained from the same sources. California continues to be by far the most important producer, but the State's production and percentage of the total were both materially reduced in 1899 as compared with 1898 or any preceding year since 1894. In 1898 California produced 93 per cent of the total product, representing 90 per cent of the total value. Last year California's percentage was 69 in amount and 70 in value. In addition to the decrease in her own production, California suffered in comparison by increased output in Texas and the Indian Territory. The reopening of the mines at Cline, in Uvalde County, Texas, with a substantial output in 1899 was one of the interesting features of the year's business.

In the following table will be found the amount and value of the asphaltum production during the past six years, by States:

Production of asphaltum since 1894, by States.

State.	1894.		1895.		1896.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
California	51,187	$251,991	64,046	$284,086	74,471	$492,663
Kentucky	5,383	21,409	2,359	11,795		
Indian Territory, Oklahoma, and Texas	*a* 3,000	45,000	*a* 1,058	29,900	*b* 2,862	35,220
Colorado and Utah	1,000	35,000	700	22,500	3,170	49,680
Total	60,570	353,400	68,163	348,281	80,503	577,563

State.	1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
California	68,650	$598,502	71,086	$605,451	52,065	$380,714
Kentucky	3,250	15,150	1,450	7,800	2,015	10,575
Indian Territory, Oklahoma, and Texas	345	3,480	*b* 1,635	7,952	*b* 17,655	82,965
Colorado and Utah	3,700	47,500	2,166	54,446	3,350	79,650
Total	75,945	664,632	76,337	675,649	75,085	553,904

a Texas only. *b* Indian Territory and Texas.

CALIFORNIA.

For several years prior to 1899 California has produced about 90 per cent of the total asphaltum and bituminous-rock product of the United States. Last year, however, because of decreased production in the State and increased output in other States, particularly in Texas and the Indian Territory, California's percentage of the total dropped to about 70 per cent. The decrease in 1899 was largely due to the closing of one of the largest maltha, or liquid asphaltum, mines in the State. There was also a decrease of 7,673 short tons, or 16 per cent, in the production of bituminous rock.

Annual production of asphaltum, etc., in California since 1888.

Year.	Bituminous rock.	Hard asphaltum.	Maltha.	Total.	Total value.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	
1888	49,300			49,300	$152,500
1889	47,968			47,968	126,885
1890				(*a*)	(*a*)
1891	39,962			39,962	154,164
1892	24,000	6,250	1,300	31,550	188,350
1893	33,000	*b* 9,650		42,650	275,662
1894	45,397	*b* 5,790		51,187	251,991
1895	51,921	8,375	3,750	64,046	284,086
1896	56,971	*c* 8,000	9,500	74,471	492,663
1897	45,426	*d* 8,454	14,650	68,650	598,502
1898	46,094	*d* 12,142	12,850	71,086	605,451
1899	38,421	*e* 12,944	700	52,065	380,714

a Not reported by States.
b Includes maltha, or liquid asphaltum.
c Includes hard crude asphaltum and refined gum.
d Includes hard crude asphaltum, mastic, and gum.
e Includes hard crude asphaltum and gum.

KENTUCKY.

Two counties in Kentucky are credited with asphaltum production in 1899, as in 1898 and 1897—Breckinridge and Logan. Grayson County has produced some in former years, but the deposits have not been worked for the last four years. The entire output is of bituminous sandstone, and its production has been comparatively small and irregular. Bituminous sandstone is reported as occurring in Butler, Carter, Warren, and Edmonson counties, but the deposits have not been developed.

No production was reported from any of the Kentucky deposits in 1896. The first product from the State was reported in 1891, since which time the output has been as follows:

Annual production of bituminous sandstone in Kentucky from 1891 to 1899.

Year.	Quantity.	Value.
	Short tons.	
1891	3,000	$6,000
1892	2,680	10,525
1893	1,929	6,570
1894	5,383	21,409
1895	2,359	11,795
1896	*None.*	*None.*
1897	3,250	15,150
1898	1,450	7,800
1899	2,015	10,575

COLORADO AND UTAH.

The production of asphaltum in these two States is combined in these reports for two reasons: First, in order to maintain the confidential nature of individual statements; second, because the gilsonite product of Colorado is from an extension eastward, into Rio Blanco County of that State, of the gilsonite deposits in the Uncompahgre Indian Reservation, Uinta County, Utah. Gilsonite is also mined in Wasatch County, Utah, and asphaltic limestone is produced in Utah County. The combined product of the two States in 1899 showed a satisfactory increase (something over 50 per cent in amount and nearly 50 per cent in value) over the output of 1898. The following table shows the production in Utah alone from 1891 to 1895, inclusive, and the combined output of Colorado and Utah since 1896. The gilsonite deposits have been fully described in previous volumes of Mineral Resources and in a report by Mr. George H. Eldridge in Part I of the Seventeenth Annual Report of the Survey. Production in 1898 shows a decrease of 42 per cent in amount, due to the partial suspension of mining operations pending the determination by the Indian Office and the parties at interest as to the boundary of the Uintah Indian Reservation.

Annual production of asphaltum, etc., in Colorado and Utah since 1891.

Year.	Quantity.	Value.
	Short tons.	
1891	*b* 1,732	$82,100
1892	*b* 2,700	93,500
1893 *a*	*b* 3,200	90,000
1894	*b* 1,000	35,000
1895	*b* 700	22,500
1896	3,170	49,680
1897	3,700	47,500
1898	2,166	54,446
1899	3,350	79,650

a Including 100 tons of ozocerite.
b Utah only. Includes Colorado since 1896.

INDIAN TERRITORY AND TEXAS.

The Indian Territory mines have not come up to expectations, so far as actual production is to be taken as the fulfillment of promises. Operations were reported in only one locality—near Dougherty. At this place a substantial increase over the product of 1898 was obtained, and up to the close of 1899 this was the only plant in successful operation in the Territory. The old lithocarbon properties in Uvalde County, Texas, have been reopened by the Uvalde Asphalt Company, and yielded a good production in 1899 after two years of idleness. The product of the Territory and of Texas is combined in order to avoid giving publicity to individual statistics.

IMPORTS.

The United States draws its chief supply of foreign asphaltum from the island of Trinidad, off the coast of Venezuela, the exports from Trinidad to the United States during the last five years averaging about the same as the domestic production. In addition to the Trinidad asphaltum, we import some from Bermudez in Venezuela, Neuchatel and Val de Travers in Switzerland, Seysel in France, Germany, Cuba, and Mexico, and small amounts from other countries.

The following table shows the imports of crude asphaltum since 1867:

Crude asphaltum imported into the United States from 1867 to 1899.

Year ending—	Quantity.	Value.	Year ending—	Quantity.	Value.
	Long tons.			*Long tons.*	
June 30, 1867..	....	$6,268	June 30, 1884..	36,078	$145,571
1868..	185	5,632	1885..	18,407	88,087
1869..	203	10,559	Dec. 31, 1886..	32,565	108,528
1870..	488	13,072	1887..	30,808	95,735
1871..	1,301	14,760	1888..	36,494	84,045
1872..	1,474	35,533	1889..	61,952	138,163
1873..	2,314	38,298	1890..	73,861	223,368
1874..	1,183	17,710	1891..	102,433	299,350
1875..	1,171	26,006	1892..	120,255	336,868
1876..	807	23,818	1893..	74,774	196,314
1877..	4,532	36,550	1894..	102,505	313,680
1878..	5,476	35,932	*a* 1895..	79,557	210,556
1879..	8,084	39,635	*a* 1896..	96,192	304,596
1880..	11,830	87,889	*a* 1897..	115,528	392,770
1881..	12,883	95,410	*b* 1898..	69,857	203,385
1882..	15,015	102,698	*c* 1899..	106,474	425,263
1883..	33,116	149,999			

a In addition to the crude asphaltum imported in 1895 there was some manufactured or refined gum asphaltum, valued at $36,664. In 1896 the value of the manufactured asphaltum imported was $77,449 and in 1897, $25,095. The quantity was not reported.

b Includes 3,069 long tons, "dried or advanced," valued at $17,005.

c Includes 4,264 long tons, "dried or advanced," valued at $35,395.

The following statement shows the amount and value of the asphaltum imported during the fiscal years ending June 30, 1897, 1898, and 1899, with the countries from which it was exported. The amount credited to Italy in 1897 is probably wholly or in part from Switzerland and shipped from an Italian seaport.

Imports of asphaltum during the fiscal years 1897, 1898, and 1899, with the countries from which exported.

Country.	1897.		1898.	
	Quantity.	Value.	Quantity.	Value.
West Indies:	*Long tons.*		*Long tons.*	
British (Trinidad)	85,034	$198,786	71,992	$217,660
Danish	400	2,000		
Cuba	223	4,180	137	2,172
Switzerland			98	530
Italy	*a* 14,581	*a* 77,456	1,260	7,531
Venezuela (Bermudez)	13,807	75,943	2,000	10,006
Germany	6,896	25,986	2,302	9,066
France	861	3,327	779	3,377
Mexico	273	3,992	438	5,773
Turkey in Asia	31	3,439	41	3,744
Great Britain	11	309	13	597
United States of Colombia	3	130		9
Canada	2	6		
Total	122,122	395,554	79,060	260,765

Country.	1899.			
	Rock or dried, etc.	Value.	Crude.	Value.
West Indies:	*Long tons.*		*Long tons.*	
British (Trinidad)	224	$3,471	68,692	$195,637
Danish				
Cuba			109	2,090
Switzerland	837	7,653		
Italy	6,443	28,276		
Venezuela (Bermudez)	8	102	3,601	18,010
Germany	1,228	6,366	254	1,449
France	648	2,539	1	77
Spain			700	7,000
Mexico			32	714
Turkey in Asia			84	8,770
Great Britain	11	613	12	384
United States of Colombia				
Canada			3	80
Netherlands			6	209
Total	9,399	49,020	73,494	234,420

a Probably including Switzerland.

PRODUCTION IN OTHER COUNTRIES.

TRINIDAD.

The island of Trinidad, off the coast of Venezuela, South America, one of the British West Indian possessions, is, next to France, the largest producer of asphaltum in the world.[1] The deposits are operated by an American corporation under a concession from the British Government, and, independently, from land not belonging to the Crown and which was acquired by purchase. The chief source of the supply is a lake of pitch filling the crater of an extinct volcano. This lake lies 138 feet above sea level and has an area of 114 acres. The supply is being partly renewed by a constant flow of soft pitch into the center of the lake from a subterranean source. The shipments of lake pitch for the last ten years have averaged over 80,000 tons per year. The flow into the lake is at the rate of about 20,000 tons per year, so that the renewal of supply is less than one-fourth the amount taken out. The depth of the lake, however, is about 135 feet at the center, and considering the extent of the deposit, there need be little apprehension of the early exhaustion of supply of Trinidad asphaltum. The material from this lake is known as "lake pitch." Distinctive from this is what is known as "land pitch," the overflow in past times of pitch from the lake, and deposits of similar nature but different origin. The overflow pitch mingled with the soil, and while it, with the other land deposits, forms another source of supply, the amount of mineral matter it contains is greater than the lake pitch, and the latter is in consequence preferred.

Mr. Ira Atkinson, treasurer of the New Trinidad Lake Asphalt Company, Limited, of New York City, has kindly furnished the following statements showing the exports of Pitch Lake asphaltum from 1881 to 1899; also the exports of land asphaltum from 1886 to 1899, and the total exports of all asphaltum from 1886 to 1899. The reasons for the smaller shipments to the United States in 1898 were explained in the report for that year. Mr. Atkinson attributes the increased figures for 1899 to a return to normal conditions and the natural increase of business with the United States.

The shipments of Trinidad asphaltum to countries other than the United States and Europe have been so comparatively insignificant that they have been included under one caption.

[1] The French asphaltum is in reality a bituminous limestone of which the bitumen contents average only about 14 per cent. Trinidad lake asphaltum, on the other hand, averages approximately 55 per cent bitumen. The product of France in 1898 was 252,358 short tons, of which the bitumen contents were about 35,300 short tons. The shipments of lake asphaltum in crude and crude equivalent from Trinidad in the same year amounted to 86,959 long tons, or 97,394 short tons, of which the bitumen contents, reckoned at 55 per cent, would be about 53,500 short tons. It will be seen from this that while France produced the largest amount in crude, Trinidad is the leader of the world in the bitumen contents of its product. Land asphaltum, of which Trinidad produces over 20,000 tons annually, has not been included in this comparison.

Exports of Pitch Lake asphaltum from Trinidad, 1881 to 1899, inclusive.

Year.	To United States.			To Europe.			To other countries.			Grand total of exports in crude equivalent.
	Crude.	Dried.	Total equivalent in crude.	Crude.	Épuré and dried.	Total equivalent in crude.	Crude.	Épuré and dried.	Total equivalent in crude.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1881	5,600	....	5,600	10,656	6,174	19,917	....	....	....	25,517
1882	12,710	....	12,710	24,712	12,007	42,722	....	....	....	55,432
1883	22,885	....	22,885	11,744	4,668	18,746	....	....	....	41,631
1884	17,885	....	17,885	15,910	6,561	25,751	....	....	....	43,636
1885	15,505	....	15,505	12,135	7,636	23,589	....	....	....	39,094
1886	22,225	....	22,225	5,130	5,394	13,221	....	....	....	35,446
1887	21,915	....	21,915	10,205	5,771	18,861	....	....	....	40,776
1888	24,321	....	24,321	8,445	8,248	20,817	....	....	....	45,138
1889	45,410	....	45,410	9,378	9,581	23,750	....	....	....	69,160
1890	39,907	....	39,907	11,755	9,951	26,681	668	....	*a* 668	67,256
1891	52,510	....	52,510	9,984	9,969	24,937	901	....	*a* 901	78,348
1892	70,806	....	70,806	11,596	9,458	25,783	1,076	....	*a* 1,076	97,665
1893	65,436	....	65,436	10,640	6,650	20,615	....	....	....	86,051
1894	71,860	....	71,860	8,967	9,413	23,086	....	....	....	94,946
1895	61,702	2,256	64,976	5,058	7,365	16,104	....	....	....	81,080
1896	60,637	....	60,637	8,320	8,052	20,391	....	1,300	*b* 1,918	82,946
1897	71,969	1,769	74,407	14,629	13,510	34,856	....	500	680	109,243
1898	46,089	1,692	48,423	15,703	13,228	35,537	*a* 693	*b* 1,646	2,999	86,959
1899 *c*	70,111	666	70,777	21,337	20,618	41,955	....	2,359	2,359	115,091

a Australia.
b Argentina and Mexico.
c The dried and "épuré" in 1899 are not reduced to crude equivalents.

Exports of land asphaltum from Trinidad, 1886 to 1899, inclusive.

Year.	To United States.			To Europe.			To other countries.			Grand total of exports in crude equivalent.
	Crude.	Épuré.	Total equivalent in crude.	Crude.	Épuré.	Total equivalent in crude.	Crude.	Épuré.	Total equivalent in crude.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1886	2,297	....	2,297	....	....	....	....	....	....	2,297
1887	1,195	2,100	4,345	220	....	220	....	....	....	4,565
1888	5,316	1,536	7,620	619	....	619	....	....	....	8,239
1889	10,490	2,052	13,568	....	....	....	833	....	*a* 833	14,401
1890	15,406	1,341	17,417	....	....	....	....	....	....	17,417
1891	20,507	7	20,517	139	....	139	40	....	*b* 40	20,696
1892	17,406	....	17,406	699	....	699	....	....	....	18,105
1893	3,450	....	3,450	2,432	1,862	5,225	110	178	*b* 377	9,052
1894	3,365	325	3,853	2,200	4,699	9,249	13	94	*b* 154	13,256
1895	4,445	199	4,744	1,770	2,368	5,322	....	169	*b* 254	10,320
1896	11,943	71	12,049	842	1,988	3,824	....	....	....	15,873
1897	19,243	....	19,243	293	700	1,343	415	178	682	21,268
1898	18,160	....	18,160	700	258	1,087	404	312	872	20,119
1899 *c*	24,622	542	25,164	275	250	525	80	298	378	26,067

a Australia.
b Canada, Venezuela, and West Indies.
c The dried and "épuré" in 1899 are not reduced to crude equivalents.

Total exports of all asphaltum from Trinidad, 1886 to 1899, inclusive.

Year.	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1886	22,225	2,297	24,522	13,221	....	13,221	....	....	....	37,743
1887	21,915	4,345	26,260	18,861	220	19,081	....	....	....	45,341
1888	24,321	7,620	31,941	20,817	619	21,436	....	....	....	53,377
1889	45,410	13,568	58,978	23,750	....	23,750	....	833	833	83,561
1890	39,907	17,417	57,324	26,681	....	26,681	668	....	668	84,673
1891	52,510	20,517	73,027	24,937	139	25,076	901	40	941	99,044
1892	70,806	17,406	88,212	25,783	699	26,482	1,076	....	1,076	115,770
1893	65,436	3,450	68,886	20,615	5,225	25,840	....	377	377	95,103
1894	71,860	3,853	75,713	23,086	9,249	32,335	....	154	154	108,202
1895	64,976	4,744	69,720	16,104	5,322	21,426	....	254	254	91,400
1896	60,637	12,049	72,686	20,391	3,824	24,215	1,918	....	1,918	98,819
1897	74,407	19,243	93,650	34,856	1,343	36,199	680	682	1,362	130,511
1898	48,423	18,160	66,583	35,537	1,087	36,624	2,999	872	3,871	107,078
1899 *a*	70,777	25,164	95,941	41,955	525	42,480	2,359	378	2,737	141,158

a The dried and "épuré" in 1899 are not reduced to crude equivalents.

FRANCE.

The Statistique de l'Industrie Minérale gives the following as the output of asphaltum in France for seven years, with the value of the product. For convenience and for comparison the quantities are expressed in metric tons and short tons, and the value both in francs and dollars:

Production of asphaltum in France from 1892 to 1898, inclusive.

Year.	Production.		Value.	
	Metric tons.	Short tons.	Francs.	Dollars.
1892	224,000	246,848	1,678,000	323,854
1893	222,000	244,644	1,612,000	311,116
1894	231,000	254,562	1,758,000	339,294
1895	267,000	294,234	1,843,000	355,700
1896	226,000	249,052	1,741,000	336,013
1897	233,328	257,127	1,699,492	328,002
1898	229,000	252,358	1,669,000	322,117

It would appear from the foregoing statement that France is the leading country of the world in the production of asphaltum. It must be remembered, however, that the French product is entirely bituminous limestone, of which the bitumen contents are only 14 per cent. As explained in the footnote to the discussion of Trinidad production, the amount of bitumen in the Trinidad lake-pitch product in 1898 was about 50 per cent more than that of the bitumen contents of

the French output, although the French product of crude was more than double that of the lake and land pitch product of Trindad combined.

GERMANY.

The production of asphaltum in the German Empire for the years 1886 to 1898, according to the official report Die Bergwerke, Salinen und Hütten im Deutschen Reich und Luxemburg, is shown in the following table. Metric tons are converted into short tons, and marks into dollars:

Production of asphaltum in Germany from 1886 to 1898, inclusive.

Year.	Production.		Value.	
	Metric tons.	Short tons.	Marks.	Dollars.
1886	42,894	47,270	216,075	51,426
1887	34,483	38,000	186,125	44,298
1888	41,534	45,770	255,250	60,749
1889	43,496	47,933	325,246	77,408
1890	51,144	56,361	377,987	89,961
1891	49,150	54,163	375,712	89,419
1892	53,279	58,713	418,850	99,686
1893	47,238	52,056	356,982	84,962
1894	55,981	61,691	451,049	107,350
1895	59,563	65,638	454,424	108,153
1896	61,552	67,830	453,394	107,908
1897	61,645	67,933	378,534	91,984
1898	a 12,822	14,130	a 81,610	19,423

a Prussia only.

ITALY.

Following Germany in amount of asphaltum produced is Italy, the product for the six years 1893 to 1898, inclusive, being shown in the following table:

Production of asphaltum in Italy from 1893 to 1898.

Year.	Production.		Value.	
	Metric tons.	Short tons.	Lire.	Dollars.
1893	25,980	28,630	565,800	109,200
1894	60,493	66,663	1,403,390	270,854
1895	46,713	51,478	1,023,751	197,584
1896	45,456	50,092	888,638	171,507
1897	55,339	60,984	948,273	183,017
1898	93,750	103,312	1,328,224	256,347

PRODUCTION OF OZOCERITE IN GALICIA.

The production of ozocerite, or mineral wax, in Galicia, Austria, since 1891, as near as can be ascertained, has been as follows:

Production of ozocerite in Galicia from 1891 to 1898.

Year.	Metric tons.	Short tons.
1891	6,158.6	6,787.0
1892	5,637.6	6,213.0
1893	5,624.8	6,198.5
1894	6,743.1	7,431.0
1895	6,644.5	7,322.0
1896	7,210.0	7,945.0
1897	(*a*)	(*a*)
1898	6,881.0	7,583.0

a Not ascertained.

SUMMARY OF WORLD'S PRODUCTION SINCE 1890.

The following table exhibits, in convenient form for comparison, the production of asphaltum in the principal producing countries, for such years as it can be obtained since 1890. In addition to the production given in this table, Russia is credited with a output of 16,640 metric tons in 1893 and 16,067 metric tons in 1894. Mexico is said to have produced some asphaltum in 1894–95, having a value of $3,751, but the quantity was not stated. The quantities in the following table have been reduced to short tons of 2,000 pounds:

Production of asphaltum in principal producing countries since 1890.

Year.	United States.		Trinidad.		Germany.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1890	40,841	$190,416	94,834	$254,019	59,361	$89,961
1891	45,054	242,264	110,929	297,132	54,163	89,419
1892	87,680	445,375	129,438	347,310	58,713	99,686
1893	47,779	372,232	106,515	285,309	52,056	84,962
1894	60,570	353,400	121,186	324,606	61,691	107,350
1895	68,163	348,281	102,368	274,200	65,638	108,153
1896	80,503	577,563	110,667	296,457	67,830	107,908
1897	75,945	664,632	146,172	292,344	67,933	91,984
1898	76,337	675,649	119,927	....	*a* 14,130	19,423

a Prussia only.

Production of asphaltum in principal producing countries since 1890—Continued.

Year.	France.		Italy.		Spain.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1890	198, 934	$335, 092	49, 728	$232, 351	47	$94
1891	278, 316	402, 631	31, 054	131, 028	274	505
1892	246, 848	323, 854	38, 107	162, 308	554	1, 014
1893	244, 644	311, 116	28, 630	109, 200	904	1, 235
1894	254, 562	339, 294	66, 663	270, 854	1, 085	1, 939
1895	294, 234	355, 700	51, 478	197, 584	870	1, 525
1896	249, 052	336, 013	50, 092	171, 507	1, 231	2, 156
1897	257, 127	328, 002	60, 984	183, 017	1, 825	3, 196
1898	252, 358	322, 117	103, 312	256, 347	2, 604	4, 605

STONE.[1]

INTRODUCTION.

Less than a score of years ago building stone as an article of commerce was limited principally to the better-known varieties of marbles and granites, which had acquired sufficient reputation to justify their shipment to various parts of the country, together with the stone used for the monumental trade. The fact was more generally recognized then than now that stones sufficiently durable for building purposes could be found at almost any place where a building was to be erected. Thus at that time a locality was characterized by a uniform type of buildings, erected with the best stone found in the neighborhood. This local character of the stone industry still exists in the majority of cities in the Old World, but the conditions of the stone trade in the United States have been revolutionized. Twenty years ago the output of building stone which had a market value away from the point of production was small compared with that of 1899, which was valued at $44,713,660. Within the twenty years combinations among stone producers have followed the lead of other productive industries; close business relations in far distant localities have brought about sharp competition, with consequent improvements in methods of producing, marketing, transporting, and finishing grades of stone formerly used only locally. Well-edited journals devoted to the interests of this trade have been developed, and with the resulting greater knowledge of the conditions of the industry it has become possible to extend this statistical inquiry each year to lower grades of stone, such as crushed rock for concrete work, and even road ballast. In these industries the quarrying, crushing, and transporting, often for long distances, have given means of livelihood to many persons.

The gradual changes which have brought about this prosperous condition of the industry have been traced from year to year in these reports, and in the present volume mention will be made only of such

[1] Owing to the severe illness of Dr. William C. Day, the stone report this year is limited to the principal tables of production, and lacks the general reviews of the stone trade which Dr. Day would otherwise have given.—Ed.

developments as have characterized the year 1899 as compared with 1898.

The total production of stone was greater in 1899 than ever before, and the production of each variety was also greater, as the whole mining industry developed with the influence of prosperous times. Each kind of building stone, with the exception of bluestone, shared in this increase, as is shown in the following table, which gives a comparison of the production of 1899 with that of 1898.

VALUE OF STONE PRODUCED IN 1898 AND 1899.

The following table shows the value of the different kinds of stone produced in the United States during the years 1898 and 1899:

Value of different kinds of stone produced in the United States during 1898 and 1899.

Kind.	1898.	1899.
Granite	*a* $9,324,406	*c* $11,618,339
Marble	3,629,940	4,011,681
Slate	3,723,540	3,962,733
Sandstone	4,724,412	6,362,944
Limestone	16,039,056	18,757,963
Bluestone	*b* 1,000,000	(*d*)
Total	38,441,354	44,713,660

a Includes trap rock, valued at $927,961.
b Estimated.
c Includes trap rock, valued at $1,275,041.
d Bluestone, valued at $815,284, is included with sandstone.

The following table shows the value of the various kinds of stone produced in 1899, by States:

Value of various kinds of stone produced in 1899, by States.

State or Territory.	Granite.	Sandstone.	Slate.	Marble.	Limestone.	Total.
Alabama	....	$71,675	....	....	$364,636	$436,311
Arizona	....	4,168	....	....	960	5,128
Arkansas	$39,470	73,616	....	$3,410	71,965	188,461
California	471,665	261,193	$6,642	6,500	287,295	1,033,295
Colorado	78,261	129,815	....	10,776	96,456	315,308
Connecticut	516,886	271,623	....	....	162,388	950,897
Delaware	1,039,349	....	....	....	....	1,039,349
Florida	....	....	....	....	44,002	44,002
Georgia	411,344	....	7,500	742,554	29,786	1,191,184
Idaho	....	....	....	....	3,325	3,325
Illinois	....	16,133	....	....	2,065,483	2,081,616
Indiana	....	35,636	....	....	2,173,833	2,209,469
Iowa	....	24,348	....	....	785,576	809,924
Kansas	....	49,629	....	....	379,001	428,630
Kentucky	....	119,982	....	....	178,861	298,843
Louisiana	....	*a* 226,503	....	....	....	226,503
Maine	1,321,082	....	181,766	....	1,028,375	2,531,223
Maryland	423,823	24,426	93,595	77,000	235,225	854,069
Massachusetts	1,798,294	131,877	800	59,416	168,147	2,158,534
Michigan	....	320,192	....	....	371,210	691,402
Minnesota	159,459	294,615	....	....	496,462	950,536
Missouri	151,688	57,662	....	....	977,399	1,186,749
Montana	*b* 9,950	26,160	....	....	113,718	149,828
Nebraska	....	....	....	....	125,017	125,017
New Hampshire	802,636	....	....	....	....	802,636
New Jersey	779,822	147,768	1,600	....	153,025	1,082,215
New Mexico	....	1,829	....	....	....	1,829
New York	306,711	1,218,053	76,675	338,816	1,545,699	3,485,954
North Carolina	225,544	10,300	....	(*c*)	....	235,844
Ohio	....	1,775,642	....	....	1,793,604	3,569,246
Oklahoma	....	....	....	....	50,550	50,550
Oregon	3,012	4,153	....	....	8,000	15,165
Pennsylvania	385,101	717,053	2,537,022	139,506	3,088,583	6,867,265
Rhode Island	400,128	....	....	....	18,239	418,367
South Carolina	361,034	....	....	....	*d* 17,650	378,684
South Dakota	91,049	18,325	....	....	45,808	155,182
Tennessee	....	....	250	384,705	208,097	593,052
Texas	84,945	35,738	....	....	100,025	220,708
Utah	4,735	29,091	1,100	2,355	6,381	43,662
Vermont	1,212,967	....	872,673	2,241,806	282,173	4,609,619
Virginia	223,380	8,000	183,110	....	255,640	670,130
Washington	42,766	58,395	....	4,837	139,339	245,337
West Virginia	....	33,860	....	....	58,802	92,662
Wisconsin	270,538	132,901	....	....	826,486	1,229,925
Wyoming	2,700	32,583	....	....	742	36,025
Total	*e* 11,618,339	*f* 6,362,944	3,962,733	4,011,681	18,757,963	44,713,660

a Includes small amounts for Idaho and Nevada.
b Includes small amount for Nevada.
c Included with Tennessee.
d Includes small amount for North Corolina.
e Includes trap rock valued at $1,275,041.
f Includes bluestone valued at $815,284.

GRANITE.

The total product in 1899 was valued at $11,618,339, compared with $9,324,406 in the previous twelve months. This increase is well distributed over the producing States. Only two, Connecticut and New York, show a decrease. Five new States, Arkansas, Montana, Nevada, Oregon, and Wyoming, come into the list of producers, as is shown in the list below. The prediction made in the last report for increased business in 1899 has been amply verified.

The following table shows the value of the granite output for 1899 as compared with that for 1898, by States:

Value of granite product in 1898 and 1899, by States.

State.	1898.	1899.
Arkansas	....	$39,470
California	$247,429	471,665
Colorado	25,923	78,261
Connecticut	682,768	516,886
Delaware	677,754	1,039,349
Georgia	339,311	411,344
Maine	1,032,621	1,321,082
Maryland	317,258	423,823
Massachusetts	1,650,508	1,798,294
Minnesota	79,309	159,459
Missouri	78,423	151,688
Montana Nevada	....	9,950
New Hampshire	683,595	802,636
New Jersey	753,513	779,822
New York	516,847	306,711
North Carolina	79,969	225,544
Oregon	....	3,012
Pennsylvania	237,780	385,101
Rhode Island	320,242	400,128
South Carolina	169,518	361,034
South Dakota	17,443	91,049
Texas	4,685	84,945
Utah	3,545	4,735
Vermont	1,084,218	1,212,967
Virginia	136,180	223,380
Washington	9,700	42,766
Wisconsin	175,867	270,538
Wyoming	....	2,700
Total	9,324,406	11,618,339

The following table shows the value of the granite production in 1899, by States and uses:

Value of granite produced in 1899, by States and uses.

State.	Sold in rough.	Dressed for building purposes.	Dressed for monumental work.	Made into paving blocks.	Curbing.	Crushed for roads.	Riprap.	Total.
Arkansas	$6,100	$12,270	$2,800	$750	$300	$15,000	$2,250	$39,470
California	45,940	41,678	32,134	41,176	12,603	292,863	5,271	471,665
Colorado	22,850	48,152	1,082	....	75	95	6,007	78,261
Connecticut	79,720	167,889	82,766	26,526	12,964	130,145	16,876	516,886
Delaware	11,408	1,935	8,252	17,511	3,748	46,495	950,000	1,039,349
Georgia	69,370	185,135	13,227	37,500	68,748	30,564	6,800	411,344
Maine	302,731	637,616	77,350	184,084	94,237	7,860	17,204	1,321,082
Maryland	104,167	137,377	21,518	24,075	27,500	106,636	2,550	423,823
Massachusetts	508,781	533,004	257,820	226,909	88,685	88,414	94,681	1,798,294
Minnesota	19,769	38,913	63,395	1,588	28,835	2,500	4,459	159,459
Missouri	14,860	12,000	2,970	34,213	61,500	25,995	150	151,688
Montana, Nevada	1,650	6,850	1,200	....	250	....	....	9,950
New Hampshire	180,109	272,368	256,397	54,099	23,437	7,480	8,746	802,636
New Jersey	56,276	48,035	....	67,793	138	606,780	800	779,822
New York	30,768	23,477	2,460	12,575	447	236,736	248	306,711
North Carolina	34,028	60,128	361	40,873	71,414	11,925	6,815	225,544
Oregon	12	....	....	3,000	....	....	....	3,012
Pennsylvania	60,692	11,809	1,339	46,290	13,445	250,520	1,006	385,101
Rhode Island	73,866	151,521	145,001	16,147	3,360	4,915	5,318	400,128
South Carolina	13,189	75,750	10,500	8,222	1,500	43,497	208,376	361,034
South Dakota	27,220	21,303	21,500	13,506	....	5,700	1,820	91,049
Texas	16,222	1,605	35,038	....	....	30,580	1,500	84,945
Utah	4,700	....	....	35	....	....	....	4,735
Vermont	563,475	125,775	509,358	3,500	7,086	1,931	1,842	1,212,967
Virginia	32,336	10,349	28,812	37,127	8,683	55,666	50,407	223,380
Washington	42,250	350	166	....	....	....	....	42,766
Wisconsin	26,742	....	112,521	72,000	16,700	42,500	75	270,538
Wyoming	2,700	....	....	....	....	....	....	2,700
Total	2,351,931	2,625,289	1,687,967	969,499	545,655	2,044,797	1,393,201	11,618,339

The only use for granite which did not present a satisfactory increase for 1899 was granite curbing, which showed a slight decline. The paving-block industry experienced a revival from the depression of 1898, though it did not equal the product of 1897. This is shown in the table below:

Value of granite paving blocks made in 1897, 1898, and 1899, by States.

State.	1897.	1898.	1899.
Arkansas			$750
California	$32,264	$46,103	41,176
Colorado		1,850	
Connecticut	76,760	26,244	26,526
Delaware	7,073	13,171	17,511
Georgia	295,005	92,550	37,500
Maine	172,637	212,109	184,084
Maryland	3,328	33,341	24,075
Massachusetts	243,750	127,483	226,909
Minnesota		10,800	1,588
Missouri	47,646	29,805	34,213
New Hampshire	26,177	47,650	54,099
New Jersey	24,006	77,579	67,793
New York	26,900	6,372	12,575
North Carolina		2,120	40,873
Oregon			3,000
Pennsylvania	11,708	30,245	46,290
Rhode Island	51,646	19,510	16,147
South Carolina	4,643	8,409	8,222
South Dakota	40,030	4,600	13,506
Utah			35
Vermont	16,770	4,446	3,500
Virginia	20,247	14,641	37,127
Washington	1,000	1,200	
Wisconsin	38,827	43,923	72,000
Total	1,140,417	854,151	969,499

The following table gives the value of the granite output, by States, for the years 1890 to 1899:

Value of the granite produced by each State, 1890 to 1899.

State.	1890.	1891.	1892.	1893.
Arkansas	(a)	$65,000	$40,000	....
California	$1,329,018	1,300,000	1,000,000	$531,322
Colorado	314,673	300,000	100,000	77,182
Connecticut	1,061,202	1,167,000	700,000	652,459
Delaware	211,194	210,000	250,000	215,964
Georgia	752,481	790,000	700,000	476,387
Idaho	....	....	....	....
Maine	2,225,839	2,200,000	2,300,000	1,274,954
Maryland	447,489	450,000	450,000	260,855
Massachusetts	2,503,503	2,600,000	2,200,000	1,631,204
Minnesota	356,782	....	360,000	270,296
Missouri	500,642	400,000	325,000	388,803
Montana	(a)	51,000	36,000	1,000
Nevada	(a)	....	....	3,000
New Hampshire	727,531	750,000	725,000	442,424
New Jersey	425,673	400,000	400,000	373,147
New York	222,773	225,000	200,000	181,449
North Carolina	146,627	....	150,000	122,707
Oregon	44,150	3,000	6,000	11,255
Pennsylvania	623,252	575,000	550,000	206,493
Rhode Island	931,216	750,000	600,000	509,799
South Carolina	47,614	50,000	60,000	95,443
South Dakota	304,673	100,000	50,000	27,828
Texas	22,550	75,000	50,000	38,991
Utah	8,700	....	15,000	590
Vermont	581,870	700,000	675,000	778,459
Virginia	332,548	300,000	300,000	103,703
Washington	(a)	....	....	....
Wisconsin	266,095	406,000	400,000	133,220
Total	14,464,095	13,867,000	12,642,000	8,808,934

a Granite valued at $76,000 was produced in Arkansas, Montana, Nevada, and Washington together, and this amount is included in the total.

Value of the granite produced by each State, 1890 to 1899—Continued.

State.	1894.	1895.	1896.	1897.	1898.	1899.
Arkansas	$28, 100	....	....	....	....	$39, 470
California	307, 000	$348, 806	$215, 883	$167, 518	$247, 429	471, 665
Colorado	49, 302	35, 000	36, 517	44, 284	25, 923	78, 261
Connecticut	504, 390	779, 361	794, 325	616, 215	682, 768	516, 886
Delaware	173, 805	73, 138	67, 775	272, 469	677, 754	1, 039, 349
Georgia	511, 804	508, 481	274, 734	436, 000	339, 311	411, 344
Idaho	....	14, 560	3, 037	1, 900	....	....
Maine	1, 551, 036	1, 400, 000	1, 195, 491	1, 115, 327	1, 032, 621	1, 321, 082
Maryland	308, 966	276, 020	251, 108	247, 948	317, 258	423, 823
Massachusetts	1, 995, 830	1, 918, 894	1, 656, 973	1, 736, 069	1, 650, 508	1, 798, 294
Minnesota	153, 936	148, 596	155, 297	92, 412	79, 309	159, 459
Missouri	98, 757	128, 987	107, 710	97, 857	78, 423	151, 688
Montana	5, 800	....	....	....	....	} 9, 950
Nevada	1, 600	3, 200	1, 250	3, 050	....	
New Hampshire	724, 702	480, 000	497, 966	641, 691	683, 595	802, 636
New Jersey	310, 965	151, 343	204, 323	561, 782	753, 513	779, 822
New York	140, 618	68, 474	161, 167	422, 216	516, 847	306, 711
North Carolina	108, 993	75, 000	40, 017	59, 236	79, 969	225, 544
Oregon	4, 993	1, 728	2, 449	1, 125	....	3, 012
Pennsylvania	600, 000	300, 000	159, 317	349, 947	237, 780	385, 101
Rhode Island	1, 211, 439	968, 473	746, 277	629, 564	320, 242	400, 128
South Carolina	45, 899	22, 083	55, 320	37, 820	169, 518	361, 034
South Dakota	8, 806	33, 279	199, 977	68, 961	17, 443	91, 049
Texas	....	....	....	3, 500	4, 685	84, 945
Utah	....	....	886	3, 854	3, 545	4, 735
Vermont	893, 956	1, 007, 718	895, 516	1, 074, 300	1, 084, 218	1, 212, 967
Virginia	123, 361	70, 426	95, 040	88, 096	136, 180	223, 380
Washington	....	....	....	5, 800	9, 700	42, 766
Wisconsin	166, 098	80, 761	126, 639	126, 134	175, 867	270, 538
Wyoming	....	....	....	....	....	2, 700
Total	10, 029, 156	8, 894, 328	7, 944, 994	8, 905, 075	9, 324, 406	11, 618, 339

The following table shows the value of the trap rock produced in the United States in 1899, by States and uses:

Value of trap rock produced in the United States in 1899, by States and uses.

State.	Sold in rough.	Made into paving blocks.	Crushed for roads or ballast.	Other purposes.	Total.
California	....	$3, 500	$44, 307	$4, 500	$52, 307
Connecticut	....	804	109, 085	865	110, 754
Massachusetts	$9, 000	....	56, 835	400	66, 235
New Jersey	4, 973	63, 918	574, 905	5, 225	649, 021
New York	....	....	162, 250	....	162, 250
Pennsylvania	10, 250	2, 000	221, 224	1, 000	234, 474
Total	24, 223	70, 222	1, 168, 606	11, 990	1, 275, 041

MARBLE.

The following table shows the value of the output of marble in the United States for the year 1899, by States:

Value of marble product in 1899, by States.

State.	Value.	State.	Value.
Arkansas	$3,410	Pennsylvania	$139,506
California	6,500	Tennessee	a 384,705
Colorado	10,776	Utah	2,355
Georgia	742,554	Vermont	2,241,806
Maryland	77,000	Washington	4,837
Massachusetts	59,416	Total	4,011,681
New York	338,816		

a Contains a small amount for North Carolina.

The above table shows an increase in the value of the marble output in 1899 over that of the output in 1898 of $381,741. The increase extends to all the uses to which marble is put. The sale of the rough material, however, falls below that of 1898 by $49,705.

The following table shows the various uses to which the marble quarried in 1896, 1897, 1898, and 1899 was put:

Distribution and value of output in 1896, 1897, 1898, and 1899 among various uses.

	1896.	1897.	1898.	1899.
Sold by producers in rough state	$583,690	$477,856	$690,240	$640,535
Sold for outside building	1,036,163	1,074,646	968,353	1,176,208
Ornamental purposes	65,365	9,010	23,904	92,942
Cemetery work (monuments and tombstones)	813,146	1,547,469	1,613,742	1,650,155
Interior decoration in buildings	329,804	576,983	304,714	389,040
Other scattering uses	30,968	184,620	28,987	62,801
Total	2,859,136	3,870,584	3,629,940	4,011,681

The following table shows the purposes for which the marble of the various productive States was sold by the quarrymen in 1896, 1897, 1898, and 1899:

Value of the marble product, by uses and States, in 1896, 1897, 1898, and 1899.

State.	Rough.	Building.	Ornamental.	Cemetery.	Interior.	Other.	Total.
1896.							
California	$4,000	....	....	....	....	....	$4,000
Georgia	171,644	$258,886	....	$98,200	$63,650	$25,000	617,380
Idaho	1,500	....	....	4,000	....	....	5,500
Iowa	23,460	10,080	$6,200	....	....	....	39,740
Maryland	....	109,000	....	....	1,000	....	110,000
Massachusetts	11,763	56,641	....	8,000	3,000	1,500	83,904
New York	69,072	365,737	....	41,682	4,471	3,198	484,160
Pennsylvania	3,022	28,500	....	....	....	....	31,522
Tennessee	190,103	....	....	....	190,000	1,270	381,373
Vermont	106,126	207,319	59,165	661,264	67,683	....	1,101,557
Total	583,690	1,036,163	65,365	813,146	329,804	30,968	2,859,136
1897.							
California	8,280	2,625	4,960	3,015	27,310	2,500	48,690
Colorado	....	....	....	....	82,000	17,600	99,600
Georgia	198,198	145,875	....	157,803	71,200	25,000	598,076
Idaho	....	....	....	4,500	500	....	5,000
Maryland	....	130,000	....	....	....	....	130,000
Massachusetts	1,026	58,608	306	2,300	16,481	1,000	79,721
New York	11,066	274,626	....	61,631	5,308	2,000	354,631
Pennsylvania	....	56,000	....	6,683	....	....	62,683
Tennessee	147,679	4,000	....	15,625	259,025	15,625	441,954
Vermont	111,607	402,912	3,744	1,295,912	115,159	120,895	2,050,229
Total	477,856	1,074,646	9,010	1,547,469	576,983	184,620	3,870,584
1898.							
California	10,800	750	17,100	1,050	10,500	....	40,200
Georgia	271,723	142,000	....	147,000	84,700	11,385	656,808
Idaho	100	....	....	4,000	100	200	4,400
Maryland	....	116,000	625	....	3,900	....	120,525
Massachusetts	1,210	25,000	....	....	12,000	....	38,210
New York	54,696	193,464	27	74,990	3,031	15,864	342,072
Pennsylvania	75	38,700	....	560	....	38	39,373
Tennessee	239,483	11,000	....	....	66,331	....	316,814
Vermont	108,553	441,439	6,152	1,386,142	124,152	1,500	2,067,938
Washington	3,600	....	....	....	....	....	3,600
Total	690,240	968,353	23,904	1,613,742	304,714	28,987	3,629,940
1899.							
Arkansas	2,850	210	140	210	....	....	3,410
California	6,200	....	....	300	....	....	6,500
Colorado	10,766	....	....	....	....	....	10,776
Georgia	335,535	97,400	....	194,600	92,350	22,669	742,554
Maryland	....	75,000	300	....	1,700	....	77,000
Massachusetts	565	43,121	2,000	1,100	8,000	4,630	59,416
New York	14,207	185,559	5,708	110,379	....	22,963	338,816
Pennsylvania	3,531	134,356	....	840	240	539	139,506
Tennessee	a 126,955	10,000	....	5,000	230,750	12,000	384,705
Utah	2,355	....	....	....	....	....	2,355
Vermont	133,411	630,562	84,107	1,337,726	56,000	....	2,241,806
Washington	4,150	....	687	....	....	....	4,837
Total	640,535	1,176,208	92,942	1,650,155	389,040	62,801	4,011,681

a Contains small amount from North Carolina.

The following table gives the production of marble, by States, for the years 1890 to 1899, both inclusive:

Value of marble, by States, from 1890 to 1899.

State.	1890.	1891.	1892.	1893.	1894.
California	$87,030	$100,000	$115,000	$10,000	$13,420
Georgia	196,250	275,000	280,000	261,666	724,385
Idaho				4,500	3,000
Maryland	139,816	100,000	105,000	130,000	175,000
Massachusetts			100,000		
New York	354,197	390,000	380,000	206,926	501,585
Pennsylvania		45,000	50,000	27,000	50,000
Tennessee	419,467	400,000	350,000	150,000	231,796
Vermont	2,169,560	2,200,000	2,275,000	1,621,000	1,500,399
Scattering	121,850	100,000	50,000		
Total	3,488,170	3,610,000	3,705,000	2,411,092	3,199,585

State.	1895.	1896.	1897.	1898.	1899.
Arkansas					$3,410
California	$22,000	$4,000	$48,690	$40,200	6,500
Colorado			99,600		10,776
Georgia	689,229	617,380	598,076	656,808	742,554
Idaho	2,250	5,500	5,000	4,400	
Iowa	13,750	39,740			
Maryland	145,000	110,000	130,000	120,525	77,000
Massachusetts	2,000	83,904	79,721	38,210	59,416
New York	207,828	484,160	354,631	342,072	338,816
Pennsylvania	59,787	31,522	62,683	39,373	139,506
Tennessee	362,277	381,373	441,954	316,814	*a* 384,705
Utah					2,355
Vermont	1,321,598	1,101,557	2,050,229	2,067,938	2,241,806
Washington				3,600	4,837
Total	2,825,719	2,859,136	3,870,584	3,629,940	4,011,681

a Contains small amount from North Carolina.

A large number of new quarries have been opened in all parts of the country and the outlook for 1900 is exceptionally bright.

SLATE.

CONDITION OF TRADE.

The condition of the slate industry for the entire country in 1899 showed an improvement over 1898. The total number of squares of roofing slate produced increased from 916,239 in 1898 to 1,100,513 in 1899. The value of milled stock, however, dropped from $594,150 in 1898 to $507,916 in 1899.

The prediction in the report for 1897 and repeated in 1898, that the export trade would become a permanent and beneficial factor in the slate industry, seems abundantly supported by the increased demand for slate for exportation.

PRODUCTION.

The following table shows the output of roofing and milled slate in 1899:

Value of slate products in 1899, by States.

State.	Roofing slate.		Other purposes than roofing; value.	Total value.
	Squares.	Value.		
California	928	$6,642		$6,642
Maine	24,676	121,640	$60,126	181,766
Maryland	20,196	90,897	2,698	93,595
New York	10,912	69,525	7,150	76,675
Pennsylvania	711,138	2,202,742	334,280	2,537,022
Vermont	277,463	777,971	94,702	872,673
Virginia	52,550	174,950	8,160	183,110
Georgia, Massachusetts, New Jersey, Tennessee, Utah	2,650	10,450	800	11,250
Total	1,100,513	3,454,817	507,916	3,962,733

The following table shows the average value of roofing slate per square since 1890:

Average annual price per square of roofing slate for the entire country.

1890	$3.34	1895	$3.23
1891	3.49	1896	3.36
1892	3.56	1897	3.09
1893	3.55	1898	3.42
1894	3.11	1899	3.15

The following table shows the value of the production of slate, by States, during the years 1890 to 1899, inclusive:

Value of slate, by States, from 1890 to 1899.

State.	1890.			
	Roofing slate.	Value.	Other purposes than roofing: value.	Total value.
	Squares.			
California	3,104	$18,089	....	$18,089
Georgia	3,050	14,850	$480	15,330
Maine	41,000	201,500	18,000	219,500
Maryland	23,099	105,745	4,263	110,008
New Jersey	2,700	9,675	1,250	10,925
New York	16,767	81,726	44,877	126,603
Pennsylvania	476,038	1,641,003	370,723	2,011,726
Vermont	236,350	596,997	245,016	842,013
Virginia	30,457	113,079	....	113,079
Other States *a*	3,060	15,240	....	15,240
Total	835,625	2,797,904	684,609	3,482,513

State.	1891.			
	Roofing slate.	Value.	Other purposes than roofing: value.	Total value.
	Squares.			
Arkansas	120	$480	....	$480
California	4,000	24,000	....	24,000
Georgia	3,000	13,500	....	13,500
Maine	50,000	250,000	....	250,000
Maryland	25,166	123,425	$2,000	125,425
New Jersey	2,500	10,000	....	10,000
New York	17,000	136,000	40,000	176,000
Pennsylvania	507,824	1,741,836	401,069	2,142,905
Vermont	247,643	698,350	257,267	955,617
Virginia	36,059	127,819	....	127,819
Total	893,312	3,125,410	700,336	3,825,746

a Includes Arkansas, Michigan, and Utah.

Value of slate, by States, from 1890 to 1899—Continued.

State.	1892.			
	Roofing slate.	Value.	Other purposes than roofing; value.	Total value.
	Squares.			
California	3,500	$21,000		$21,000
Georgia	2,500	10,625		10,625
Maine	50,000	250,000		250,000
Maryland	24,000	114,000	$2,500	116,500
New Jersey	3,000	12,000		12,000
New York	20,000	160,000	50,000	210,000
Pennsylvania	550,000	1,925,000	408,000	2,333,000
Vermont	260,000	754,000	260,000	1,014,000
Virginia	40,000	150,000		150,000
Total	953,000	3,396,625	720,500	4,117,125

State.	1893.			
	Roofing slate.	Value.	Other purposes than roofing; value.	Total value.
	Squares.			
Georgia	2,500	$11,250		$11,250
Maine	18,184	124,200	$15,000	139,200
Maryland	7,422	37,884		37,884
New Jersey	900	3,653		3,653
New York	69,640	204,776	206	204,982
Pennsylvania	364,051	1,314,451	157,824	1,472,275
Utah	75	450	400	850
Vermont	132,061	407,538	128,194	535,732
Virginia	27,106	104,847	12,500	117,347
Total	621,939	2,209,049	314,124	2,523,173

Value of slate, by States, from 1890 to 1899—Continued.

State.	1894.			
	Roofing slate.	Value.	Other purposes than roofing; value.	Total value.
	Squares.			
California	900	$5,850	....	$5,850
Georgia	5,000	22,500	....	22,500
Maine	24,690	123,937	$22,901	146,838
Maryland	39,460	150,568	2,500	153,068
New Jersey	375	1,050	....	1,050
New York	7,955	42,092	2,450	44,542
Pennsylvania	411,550	1,380,430	239,728	1,620,158
Vermont	214,337	455,860	202,307	658,167
Virginia	33,955	118,851	19,300	138,151
Total	738,222	2,301,138	489,186	2,790,324

State.	1895.			
	Roofing slate.	Value.	Other purposes than roofing; value.	Total value.
	Squares.			
California	1,500	$10,500	....	$10,500
Georgia	2,500	10,675	....	10,675
Maine	23,774	118,791	$21,363	140,154
Maryland	13,188	59,157	1,200	60,357
New Jersey	200	700	....	700
New York	13,624	90,150	1,725	91,875
Pennsylvania	426,687	1,437,697	210,054	1,647,751
Vermont	221,359	531,482	93,849	625,331
Virginia	27,095	92,357	19,000	111,357
Total	729,927	2,351,509	347,191	2,698,700

Value of slate, by States, from 1890 to 1899—Continued.

State.	1896.			
	Roofing slate.	Value.	Other purposes than roofing: value.	Total value.
	Squares.			
Georgia	4,597	$20,388	....	$20,388
Maine	23,078	99,831	$24,255	124,086
Maryland	15,557	70,194	1,948	72,142
Massachusetts	....	....	1,200	1,200
New Jersey	200	700	....	700
New York	16,002	78,612	3,880	82,492
Pennsylvania	431,324	1,391,539	334,779	1,726,318
Tennessee	160	640	780	1,420
Vermont	155,523	509,681	99,915	609,596
Virginia	26,863	92,163	15,700	107,863
Total	673,304	2,263,748	482,457	2,746,205

State.	1897.			
	Roofing slate.	Value.	Other purposes than roofing: value.	Total value.
	Squares.			
California	1,000	$7,000	....	$7,000
Maine	38,367	161,262	$39,855	201,117
Maryland	11,592	53,049	890	53,939
Minnesota	400	1,000	500	1,500
New Jersey	250	775	....	775
New York	9,197	52,799	1,000	53,799
Pennsylvania	657,692	2,034,958	330,341	2,365,299
Vermont	244,575	656,114	39,701	695,815
Virginia	38,375	130,495	14,875	145,370
Total	1,001,448	3,097,452	427,162	3,524,614

Value of slate, by States, from 1890 to 1899—Continued.

State.	1898.			
	Roofing slate.	Value.	Other purposes than roofing; value.	Total value.
	Squares.			
California	400	$2,700	....	$2,700
Georgia	3,450	13,125	....	13,125
Maine	29,834	131,752	$67,485	199,237
Maryland	18,332	80,786	1,454	82,240
Massachusetts	....	....	958	958
Minnesota	100	400	....	400
New Jersey	200	800	....	800
New York	7,160	46,744	1,950	48,694
Pennsylvania	571,256	2,097,735	394,021	2,491,756
Vermont	241,762	612,902	119,782	732,684
Virginia	43,745	142,446	8,500	150,946
Total	916,239	3,129,390	594,150	3,723,540

State.	1899.			
	Roofing slate.	Value.	Other purposes than roofing; value.	Total value.
California	928	$6,642	....	$6,642
Maine	24,676	121,640	$60,126	181,766
Maryland	20,196	90,897	2,698	93,595
New York	10,912	69,525	7,150	76,675
Pennsylvania	711,138	2,202,742	334,280	2,537,022
Vermont	277,463	777,971	94,702	872,673
Virginia	52,550	174,950	8,160	183,110
Georgia Massachusetts New Jersey Tennessee Utah	2,650	10,450	800	11,250
Total	1,100,513	3,454,817	507,916	3,962,733

EXPORTS.

The following table shows the ports and customs districts from which and to which slate has been exported since 1893:

Exports of slate from United States, showing ports and customs districts from which and to which sent, from 1893 to 1899.

Port and customs district.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
ROOFING SLATE.							
Baltimore, Maryland	....	....	....	$9,860	$101,581	$170,916	$99,083
Bangor, Maine	....	$445	....	350	....	....	....
Boston and Charlestown, Massachusetts	$1,086	....	$443	609	1,020	385	40,622
Newport News, Virginia	....	....	....	....	18,170	65,290	42,220
New York, New York	36,306	19,684	31,092	242,559	557,099	986,638	968,395
Passamaquoddy, Maine	....	....	192	....	120	....	....
Philadelphia, Pennsylvania	....	....	....	2,300	94,865	136,916	205,779
Portland and Falmouth, Maine	....	....	....	....	270	....	....
Brazos de Santiago, Texas	5	....	....	....	....	....	14
Corpus Christi, Texas	....	....	105	174	....	1,761	....
New Orleans, Louisiana	....	587	....	....	....	....	....
Paso del Norte, Texas	....	621	....	....	....	....	....
Puget Sound, Washington	....	....	....	....	....	22	67
San Diego, California	....	....	....	....	....	....	7
Buffalo Creek, New York	13,428	13,696	4,748	5,903	2,378	4,141	6,364
Champlain, New York	869	1,869	1,961	1,617	613	3,015	937
Detroit, Michigan	....	....	65	2,874	2,427	854	129
Huron, Michigan	200	....	....	....	....	....	....
North and South Dakota	94	160	....	....	....	137	....
Vermont	24	133	200	139	1,569	....	....
Total	52,012	37,195	38,806	266,385	780,112	1,370,075	1,363,617
Belgium	....	....	....	....	....	....	524
France	....	....	....	12,000	....	....	....
Germany	....	....	25	910	5,850	82,916	65,974
Netherlands	....	....	....	....	2,087	25	520
United Kingdom	1,400	4,800	3,000	197,440	695,980	1,213,377	1,188,962
Denmark	....	....	....	....	....	8,150	25,323
Norway and Sweden	....	....	....	....	....	270	669
Bermuda	1,046	336	1,550	2,312	1,395	157	230
Dominion of Canada:							
Nova Scotia, New Brunswick, etc	119	445	406	1,278	730	....	288
Quebec, Ontario, etc	14,615	15,858	6,974	10,533	6,977	8,147	7,430
British Columbia	....	....	....	....	....	22	67
Newfoundland and Labrador	32	....	13	....	....	....	....
Central American States:							
Guatemala	....	....	....	....	....	1,755	....
Honduras	....	587	....	....	....	....	....
Mexico	22	621	488	821	150	1,872	330
Miquelon, Langley, etc	....	....	....	....	....	35	....

Exports of slate from United States, showing ports and customs districts from which and to which sent, from 1893 to 1899—Continued.

Port and customs district.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
ROOFING SLATE—continued.							
West Indies:							
British		$3,803	$4,419	$1,159	$1,860	$2,356	$1,400
Haiti		330				26	
Santo Domingo			10				
Cuba		2,643	3,258	90		673	16
Colombia				259	100		
Guianas:							
British		712	702	440	165	600	
Dutch	$3,145		340		1,640	1,325	2,275
Peru	405						
Uruguay				417		807	760
China						110	
East Indies—British				1,628	810	550	
British Australasia	30,362	7,060	17,363	34,970	60,604	41,642	64,434
Hawaiian Islands				245	166		77
British Africa	866		258	1,883	1,598	2,218	1,335
Portuguese Africa						42	3
Total	52,012	37,195	38,806	266,385	780,112	1,370,075	1,363,617

THE SLATE INDUSTRY IN INDIVIDUAL STATES.

CALIFORNIA.

The value of the slate output in California increased from $2,700 in 1898 to $6,642 in 1899. The demand was good, and indications for 1900 are particularly bright.

GEORGIA, MASSACHUSETTS, NEW JERSEY, TENNESSEE, AND UTAH.

Owing to the fact that in the year 1899 there was only one operator in each of the above States, it has been deemed best to lump their output so as to protect the interests of the producers concerned. The value of the combined output was $11,250. In Georgia the demand was good, but lack of capital prevented very active operations. Massachusetts, New Jersey, and Utah are not regular slate-producing States, and only contribute to the national output from time to time. While Tennessee has not been a large slate producer as yet, it is probable that with proper transportation facilities the State would enter the list of slate-producing States as a regular contributor whose output would materially increase the total figures for the country.

MAINE.

While the general tone of the slate trade in Maine in 1899 was good and prices advanced a little, the total value of the product was slightly below that for 1898. In 1898 the value of the output was $199,237, while in 1899 it was $181,766.

MARYLAND.

The value of the output of slate in this State increased from $82,240 in 1898 to $93,595 in 1899. The demand was good and the promise for 1900 better. A number of the firms have merged into the Proctor Slate Company.

NEW YORK.

The value of the slate output in this State increased from $48,694 in 1898 to $76,675 in 1899. There was a considerable falling off in the demand for red slate, but the sale and output of other kinds of slate were exceptionally good.

PENNSYLVANIA.

Pennsylvania, the largest slate-producing State in the United States, produced slate valued at $2,537,022 in 1899, or practically the same as in 1898. The export trade is reported as having improved, while the demand for home consumption was not so good as in 1898. The figure for value of milled stock in 1898 was $394,021; in 1899 it was $334,280. This falling off of $59,741 in milled stock can no doubt be attributed to the decrease in the demand for home consumption.

VERMONT.

The value of the output in this State increased from $732,684 in 1898 to $872,673 in 1899. The demand was very good, with prices much improved. The prospects for 1900 are excellent.

VIRGINIA.

In spite of the loss of much valuable time from landslides in several of the larger quarries, and the closing down of active production while stripping new quarry space, the value of the output in this State advanced from $150,946 in 1898 to $183,110 in 1899. The demand was good and the prospects for 1900 are still better.

SANDSTONE.

Like other kinds of building stone, sandstone showed a remarkable increase in 1899, the value being 35 per cent greater than in 1898. The development was irregular. New York, Ohio, and Pennsylvania showed the greatest gains, while many minor regions and some producers of average size declined slightly.

The following table shows the output of sandstone in the United States for 1899, by States; the output for 1898 is given for comparison.

Value of the sandstone product for 1898 and 1899, by States.

State.	1899.	1898.
Alabama	$71,675	$27,882
Arizona	4,168	57,444
Arkansas	73,616	24,825
California	261,193	358,908
Colorado	129,815	89,637
Connecticut	271,623	215,733
Illinois	16,133	13,758
Indiana	35,636	45,342
Iowa	24,348	7,102
Kansas	49,629	19,528
Kentucky	119,982	72,525
Louisiana	*a* 226,503	200,500
Maryland	24,426	13,646
Massachusetts	131,877	91,287
Michigan	320,192	222,376
Minnesota	294,615	175,810
Missouri	57,662	48,795
Montana	26,160	3,682
New Jersey	147,768	257,217
New Mexico	1,829	3,500
New York *b*	1,218,053	566,133
North Carolina	10,300	9,100
Ohio	1,775,642	1,494,746
Oregon	4,153	7,864
Pennsylvania *b*	717,053	478,451
South Dakota	18,325	9,000
Texas	35,738	77,190
Utah	29,091	15,752
Virginia	8,000	....
Washington	58,395	15,575
West Virginia	33,860	14,381
Wisconsin	132,901	80,341
Wyoming	32,583	6,382
Total	6,362,944	4,724,412

a Includes small amounts for Idaho and Nevada. *b* Includes bluestone.

The following table shows the value of sandstone produced in the United States in 1899, by States and uses:

Value of sandstone product in the United States in 1899, by States and uses.

State.	Sold in rough.	Dressed, for building purposes.	Sold for curbing and flagstone.	Sold for grindstones.	Sold for whetstones.	Sold for fire-brick.	Other purposes.	Total.
Alabama	$17,500	$39,175	$15,000					$71,675
Arizona	3,680	488						4,168
Arkansas	34,091	13,475	26,050					73,616
California	186,216	73,009					$1,968	261,193
Colorado	60,138	25,673	37,229				6,775	129,815
Connecticut	175,918	62,839					32,866	271,623
Illinois	3,162	10,800	256				1,915	16,133
Indiana	24,030	4,150	376		$7,080			35,636
Iowa	4,714	17,904	1,700					24,318
Kansas	3,735	1,010	34,069				10,815	49,629
Kentucky	45,203	71,629	2,650				500	119,982
Louisiana	*a* 226,503							226,503
Maryland	759	23,667						24,426
Massachusetts	60,244	70,433					1,200	131,877
Michigan	102,447	51,682	109	$138,115	4,039		23,800	320,192
Minnesota	59,181	144,732	88,702				2,000	294,615
Missouri	49,368	6,541	1,297	27			429	57,662
Montana	19,160					$7,000		26,160
New Jersey	57,978	89,390	400					147,768
New Mexico	1,030	18	781					1,829
New York	306,168	241,823	376,971	86,324	177,943		28,824	1,218,053
North Carolina		10,000	300					10,300
Ohio	249,211	434,978	572,111	480,963	3,440		34,939	1,775,642
Oregon	4,153							4,153
Pennsylvania *b*	184,464	298,598	102,891	51,927	16,265	156	62,752	717,053
South Dakota	14,050	3,425	575				275	18,325
Texas	3,338	9,600	21,800				1,000	35,738
Utah	3,970	24,341	20				760	29,091
Virginia	2,000	6,000						8,000
Washington	42,495	12,550	2,550				800	58,395
West Virginia	7,040	18,660	600	3,510			4,050	33,860
Wisconsin	36,118	83,537	7,165	375			5,706	132,901
Wyoming	9,938	15,145					7,500	32,583
Total	1,998,032	1,865,272	1,293,602	761,241	208,767	7,156	228,874	6,362,944

a Includes small amounts for Idaho and Nevada. *b* Includes bluestone.

The bluestone product in New York and Pennsylvania is included here for want of a better place, and is shown in the following table:

Value of bluestone produced in the United States in 1899, by States.

State.	Value.
New York	$664,484
Pennsylvania	150,800
Total	815,284

The following table gives the value of the sandstone output, by States, for the years 1890 to 1899:

Value of sandstone from 1890 to 1899, by States.

State.	1890.	1891.	1892.	1893.	1894.
Alabama	$43,965	$30,000	$32,000	$5,400	$18,100
Arizona	9,146	1,000	35,000	46,400	...
Arkansas	25,074	20,000	18,000	3,292	2,365
California	175,598	100,000	50,000	26,314	10,087
Colorado	1,224,098	750,000	550,000	126,077	69,105
Connecticut	920,061	750,000	650,000	570,346	322,934
Florida	(a)	...	...	...	...
Georgia	(a)	...	2,000	...	11,300
Idaho	2,490	...	3,000	2,005	10,529
Illinois	17,896	10,000	7,500	16,859	10,732
Indiana	43,983	90,000	80,000	20,000	22,120
Iowa	80,251	50,000	25,000	18,347	11,639
Kansas	149,289	80,000	70,000	24,761	30,265
Kentucky	117,940	80,000	65,000	18,000	27,868
Maryland	10,605	10,000	5,000	360	3,450
Massachusetts	649,097	400,000	400,000	223,348	160,231
Michigan	246,570	275,000	500,000	75,547	34,066
Minnesota	131,979	290,000	175,000	80,296	8,415
Missouri	155,557	100,000	125,000	75,701	131,687
Montana	31,648	35,000	35,000	42,300	16,500
Nevada	(a)	...	...	...	...
New Hampshire	3,750	...	...	...	...
New Jersey	597,309	400,000	350,000	267,514	217,941
New Mexico	186,804	50,000	20,000	4,922	300
New York	702,419	500,000	450,000	415,318	450,992
North Carolina	12,000	15,000	...	...	...
Ohio	3,046,656	3,200,000	3,300,000	2,201,932	1,777,034
Oregon	8,424	...	35,000	...	...
Pennsylvania	1,609,159	750,000	650,000	622,552	349,787
Rhode Island	(a)	...	...	...	...
South Dakota	93,570	25,000	20,000	36,165	9,000
Tennessee	2,722	...	...	...	...
Texas	14,651	6,000	48,000	77,675	62,350
Utah	48,306	36,000	40,000	136,462	15,428
Vermont	(a)	...	...	...	...
Virginia	11,500	40,000	...	3,830	2,258
Washington	75,936	75,000	75,000	15,000	6,611
West Virginia	140,687	90,000	85,000	46,135	63,865
Wisconsin	183,958	417,000	400,000	92,193	94,888
Wyoming	16,760	25,000	15,000	100	4,000
Total	10,816,057	8,700,000	8,315,500	5,295,151	3,955,847

a Sandstone valued at $26,190 was produced by Rhode Island, Nevada, Vermont, Florida, and Georgia together, and this sum is included in the total.

Value of sandstone from 1890 to 1899, by States—Continued.

State.	1895.	1896.	1897.	1898.	1899.
Alabama	$31,930	$48,000	$3,000	$27,882	$71,675
Arizona	20,000	10,000	15,000	57,444	4,168
Arkansas	13,228	1,400	3,161	24,825	73,616
California	11,933	7,267	4,035	358,908	261,193
Colorado	63,237	58,989	60,847	89,637	129,815
Connecticut	397,853	426,029	364,604	215,733	271,623
Georgia		1,250			
Idaho	6,900	16,060			
Illinois	6,558	15,061	14,250	13,758	16,133
Indiana	60,000	32,847	35,561	45,342	35,636
Iowa	5,575	12,351	14,771	7,102	24,348
Kansas	93,394	18,804	20,953	19,528	49,629
Kentucky	25,000		40,000	72,525	119,982
Louisiana			8,000	200,500	*a* 226,503
Maryland	16,836	10,713		13,646	24,426
Massachusetts	339,487	304,361	194,684	91,287	131,877
Michigan	159,075	111,321	171,127	222,376	320,192
Minnesota	74,700	202,900	158,057	175,810	294,615
Missouri	100,000	51,144	57,583	48,795	57,662
Montana	31,069	3,250	25,644	3,682	26,160
New Jersey	111,823	126,534	190,976	257,217	147,768
New Mexico	2,700			3,500	1,829
New York	415,644	223,175	544,514	566,133	*b* 1,218,053
North Carolina	3,500	13,250	11,500	9,100	10,300
Ohio	1,449,659	1,679,265	1,600,058	1,494,746	1,775,642
Oregon				7,864	4,153
Pennsylvania	500,000	446,926	380,813	478,451	*b* 717,053
South Dakota	26,100	37,077		9,000	18,325
Tennessee		4,100			
Texas	97,336	36,000	30,030	77,190	35,738
Utah	5,000	7,860	7,907	15,752	29,091
Virginia					8,000
Washington	14,777	11,090	16,187	15,575	58,395
West Virginia	40,000	24,693	47,288	14,381	33,860
Wisconsin	78,000	65,017	33,620	80,341	132,901
Wyoming	10,000	16,465	11,275	6,382	32,583
Total	4,211,314	4,023,199	4,065,445	4,724,412	6,362,944

a Includes small amounts for Idaho and Nevada. *b* Includes bluestone.

Inspection of this table shows that the output has increased over 1898, for which year the value was $4,724,412, while for 1899 it was $6,362,944.

LIMESTONE.

In this industry, as in the other branches of the stone trade, the total increase for the year was eminently satisfactory; and, as in other cases, the greatest increases came from the large producers, while the declines were the exception and were limited to much less important quarries.

The following table shows the production of limestone in the United States in 1899, by States and uses:

Production of limestone in the United States in 1899, by States and uses.

State or Territory.	Building purposes.	Paving and road making.	Riprap.	Made into lime.	Stone sold to lime burners.	Flux.	Other purposes.	Total.
Alabama	$37,250	$16,021	$150	$118,928	$7,450	$184,837	....	$364,636
Arizona	....	....	....	960	....	....	....	960
Arkansas	21,230	785	10,850	38,240	800	....	$60	71,965
California	1,551	9,915	....	263,406	....	525	11,898	287,295
Colorado	....	150	....	33,675	....	62,431	200	96,456
Connecticut	....	....	....	161,945	....	443	....	162,388
Florida	18,000	17,402	....	8,600	....	....	....	44,002
Georgia	....	....	....	29,786	....	....	....	29,786
Idaho	25	....	....	3,300	....	....	....	3,325
Illinois	1,067,622	561,329	99,976	194,773	9,000	80,810	51,973	2,065,483
Indiana	1,400,854	272,969	8,678	273,901	192	184,570	32,369	2,173,833
Iowa	312,595	158,917	139,064	102,611	1,505	....	70,881	785,[illegible]76
Kansas	209,680	75,443	57,023	2,615	....	....	34,240	379,001
Kentucky	101,094	44,845	7,510	12,672	....	6,248	3,492	178,861
Maine	....	....	....	1,001,368	16,396	2,543	8,068	1,028,375
Maryland	8,896	7,292	51	217,522	794	75	595	235,225
Massachusetts	6,100	250	....	159,997	....	1,675	125	168,147
Michigan	30,299	62,815	1,111	89,441	157,657	27,512	2,375	371,210
Minnesota	325,856	26,105	75,335	52,851	....	3,840	12,475	496,462
Missouri	242,469	284,153	47,020	383,543	385	10,231	9,298	977,399
Montana	....	....	....	13,818	....	99,900	....	113,718
Nebraska	33,571	24,948	36,962	2,000	2,960	18,000	6,576	125,017
New Jersey	705	1,824	....	108,056	914	41,526	....	153,025
New York	574,372	337,775	5,965	522,480	14,206	43,042	47,859	1,545,699
Ohio	250,816	315,890	11,828	802,228	29,841	313,936	69,065	1,793,604
Oklahoma Ter.	10,050	40,500	....	....	....	....	....	50,550
Oregon	....	....	....	8,000	....	....	....	8,000
Pennsylvania	195,116	230,907	46,187	1,132,760	147,204	1,278,632	57,777	3,088,583
Rhode Island	....	....	....	18,239	....	....	....	18,239
South Carolina *a*	....	....	....	17,650	....	....	....	17,650
South Dakota	150	....	....	10,001	....	35,357	....	45,808
Tennessee	79,550	11,225	1,250	93,137	2,500	17,130	305	208,097
Texas	3,940	357	858	79,399	....	15,471	....	100,025
Utah	3,898	56	....	1,033	....	1,394	....	6,381
Vermont	....	13	....	281,560	....	....	600	282,173
Virginia	12,622	6,788	4	111,339	10	119,477	5,400	255,640
Washington	....	....	....	133,646	....	....	5,693	139,339
West Virginia	1,345	296	10	54,259	558	2,334	....	58,802
Wisconsin	122,202	135,276	15,020	442,586	174	28,860	52,368	826,486
Wyoming	....	....	....	742	....	....	....	742
Total	[illegible],075,158	2,647,516	[illegible]04,862	6,983,067	392,846	2,580,799	483,605	18,757,963

a Contains a small amount for North Carolina.

The following table shows the value of limestone, by States, since 1890:

Value of limestone from 1890 to 1899, by States.

State or Territory.	1890.	1891.	1892.
Alabama	$324, 814	$300, 000	$325, 000
Arizona	(a)		
Arkansas	18, 360	20, 000	18, 000
California	516, 780	400, 000	400, 000
Colorado	138, 091	90, 000	100, 000
Connecticut	131, 697	100, 000	95, 000
Florida	(a)		
Georgia	(a)		
Idaho	28, 545		5, 000
Illinois	2, 190, 607	2, 030, 000	3, 185, 000
Indiana	1, 889, 336	2, 100, 000	1, 800, 000
Iowa	530, 863	400, 000	705, 000
Kansas	478, 822	300, 000	310, 000
Kentucky	303, 314	250, 000	275, 000
Maine	1, 523, 499	1, 200, 000	1, 600, 000
Maryland	164, 860	150, 000	200, 000
Massachusetts	119, 978	100, 000	200, 000
Michigan	85, 952	75, 000	95, 000
Minnesota	613, 247	600, 000	600, 000
Missouri	1, 859, 960	1, 400, 000	1, 400, 000
Montana	24, 964		6, 000
Nebraska	207, 019	175, 000	180, 000
New Jersey	129, 662	100, 000	180, 000
New Mexico	3, 862	2, 000	5, 000
New York	1, 708, 830	1, 200, 000	1, 200, 000
Ohio	1, 514, 934	1, 250, 000	2, 025, 000
Oregon	(a)		
Pennsylvania	2, 655, 477	2, 100, 000	1, 900, 000
Rhode Island	27, 625	25, 000	30, 000
South Carolina	14, 520	50, 000	50, 000
South Dakota	(a)		
Tennessee	73, 028	70, 000	20, 000
Texas	217, 835	175, 000	180, 000
Utah	27, 568		8, 000
Vermont	195, 066	175, 000	200, 000
Virginia	159, 023	170, 000	185, 000
Washington	231, 287	25, 000	100, 000
West Virginia	93, 856	85, 000	85, 000
Wisconsin	813, 963	675, 000	675, 000
Wyoming	(a)		
Total	19, 095, 179	15, 792, 000	18, 342, 000

a Limestone valued at $77,935 was produced in Oregon, Georgia, Florida, Arizona, South Dakota, and Wyoming. The value is included in the total.

Value of limestone from 1890 to 1899, by States—Continued.

State.	1893.	1894.	1895.
Alabama	$205,000	$210,269	$222,424
Arizona	15,000	19,810	24,159
Arkansas	7,611	38,228	47,376
California	288,626	288,900	322,211
Colorado	60,000	132,170	116,355
Connecticut	155,000	204,414	154,333
Florida	35,000	30,639	10,550
Georgia	34,500	32,000	12,000
Idaho	1,000	5,315	7,829
Illinois	2,305,000	2,555,952	1,687,662
Indiana	1,474,695	1,203,108	1,658,976
Iowa	547,000	616,630	449,501
Kansas	175,173	241,039	316,688
Kentucky	203,000	113,934	154,130
Maine	1,175,000	810,089	700,000
Maryland		350,000	200,000
Massachusetts	156,528	195,982	75,000
Michigan	53,282	336,287	424,589
Minnesota	208,088	291,263	218,733
Missouri	861,563	578,802	897,318
Montana	4,100	92,970	95,121
Nebraska	158,927	8,228	7,376
New Jersey	149,416	193,523	150,000
New Mexico		4,910	3,375
New York	1,103,529	1,378,851	1,043,182
North Carolina			
Ohio	1,848,063	1,733,477	1,568,713
Oklahoma Territory			
Oregon	15,100		970
Pennsylvania	1,552,336	2,625,562	3,055,913
Rhode Island	24,800	20,433	
South Carolina	22,070	25,100	
South Dakota	100	3,663	4,000
Tennessee	126,089	188,664	156,898
Texas	28,100	41,526	62,526
Utah	17,146	23,696	22,503
Vermont	151,067	408,810	300,000
Virginia	82,685	284,547	268,892
Washington	139,862	59,148	75,910
West Virginia	19,184	43,773	42,892
Wisconsin	543,283	798,406	750,000
Wyoming			650
Total	13,947,223	16,190,118	15,308,755

Value of limestone from 1890 to 1899, by States—Continued.

State.	1896.	1897.	1898.	1899.
Alabama	$180,921	$221,811	$242,295	$364,636
Arizona	18,470	11,522	1,782	960
Arkansas	30,708	44,222	54,373	71,965
California	143,865	308,925	229,729	287,295
Colorado	65,063	79,256	109,310	96,456
Connecticut	138,945	178,410	142,057	162,388
Florida	16,982	18,889	91,330	44,002
Georgia	29,081	32,000	57,803	29,786
Idaho	5,662	15,538	3,080	3,325
Illinois	1,261,359	1,483,157	1,421,072	2,065,483
Indiana	1,658,499	2,012,608	1,686,572	2,173,833
Iowa	410,037	480,572	524,546	785,576
Kansas	158,112	208,889	305,605	379,001
Kentucky	135,967	40,815	83,960	178,861
Maine	608,077	742,877	1,283,468	1,028,375
Maryland	264,278	181,637	433,653	235,225
Massachusetts	118,622	126,508	174,822	168,147
Michigan	109,427	215,177	271,523	371,210
Minnesota	228,992	236,397	345,685	496,462
Missouri	802,968	1,018,202	735,275	977,399
Montana	83,927	37,300	63,196	113,718
Nebraska	10,655	42,359	78,493	125,017
New Jersey	134,213	141,646	146,611	153,025
New Mexico	....	....	....	....
New York	1,591,966	1,697,780	1,533,936	1,545,699
North Carolina *a*	....	....	1,605	....
Ohio	1,399,412	1,486,550	1,673,160	1,793,604
Oklahoma Territory	....	....	3,000	50,550
Oregon	1,600	....	7,480	8,000
Pennsylvania	2,104,774	2,327,870	2,746,256	3,088,583
Rhode Island	11,589	11,555	10,215	18,239
South Carolina	26,000	30,000	34,000	17,650
South Dakota	3,126	3,895	26,858	45,808
Tennessee	157,176	113,774	182,402	208,097
Texas	77,252	57,258	70,321	100,025
Utah	9,358	9,250	11,721	6,381
Vermont	147,138	165,657	174,150	282,173
Virginia	182,640	192,972	182,852	255,640
Washington	83,742	126,877	140,239	139,339
West Virginia	59,113	61,546	56,167	58,802
Wisconsin	552,921	641,232	698,454	826,486
Wyoming	....	....	....	742
Total	13,022,637	14,804,933	16,039,056	18,757,963

a A small amount for 1899 is included with South Carolina.

CLAY.

PRODUCTION.

The following table shows the production and value of the clay mined in 1898 and 1899 by those who do not manufacture the clay reported into wares, but sell it to clay workers. While the caption to the table indicates that the clay is sold in a raw state, and this is true as to by far the larger part of the product, still in many instances the values given include the cost of the simple processes of grinding and washing, it having been found impracticable to separate the raw clay from that thus treated in the collection of these figures.

The product in 1899 was valued at $1,645,328, as compared with $1,384,766 in 1898, a gain of $260,562, or 18.82 per cent.

Production and value of raw clay in the United States in 1898 and 1899, by States.

1899.

[Tons of 2,000 pounds.]

State.	Kaolin or china.		Ball.		Fire.		Pipe.		Terra-cotta clay.		Miscellaneous.(d)		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Tons.	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Dollars.*
Alabama	(a)	(a)			14,881	9,784			(a)	(a)			10,679
Arizona					(a)	(a)							2,000
California	(a)	(a)			3,902	1,660	5,410	5,420					10,105
Colorado	(a)	(a)	(a)	(a)	8,578	8,259	(a)	(a)					20,735
Connecticut b	(a)	(a)			(a)	(a)	(a)	(a)			(a)	(a)	2,641
Delaware	21,900	71,479			(a)	(a)							71,742
Florida	(a)	(a)											50,000
Illinois			(a)	(a)	17,338	16,908	6,530	5,256	31,414	29,869	16,866	9,971	100,049
Indiana					2,269	2,030	(a)	(a)			712	665	3,383
Iowa			(a)	(a)	(a)	(a)							4,682
Kentucky			(a)	(a)	(a)	(a)							21,632
Maryland	(a)	(a)	(a)	(a)	2,138	1,705	(a)	(a)	(a)	(a)	2,500	1,025	3,955
Michigan	2,275	5,650											5,650
Missouri	1,675	8,419	(a)	(a)	90,599	347,493			2,351	4,368	2,700	1,620	375,400
New Jersey	5,566	11,801	7,178	38,105	178,048	264,286	32,568	19,357	52,439	61,352	23,100	45,973	440,874
New York	(a)	(a)	(a)	(a)	1,603	3,008	(a)	(a)	(a)	(a)	1,156	3,854	10,140
North Carolina	9,945	76,760	76	33	(a)	(a)	(a)	(a)					76,846
Ohio			940	700	56,163	40,169	(a)	(a)	2,573	2,508	14,559	8,691	52,271
Pennsylvania	19,307	111,641			78,151	102,089	(a)	(a)			1,022	6,335	235,068
South Carolina	19,951	93,699			300	1,200							94,899
Tennessee					1,148	710					100	100	810
West Virginia					(a)	(a)							13,967
Wisconsin	(a)	(a)											37,800
Other States c	13,485	91,830	14,568	70,531	23,878	24,618	45,445	27,669	2,884	3,647	85	75	(e)
Total	97,107	471,282	22,762	109,369	478,996	826,919	89,953	57,702	91,661	101,744	62,800	78,312	1,645,328

a Included in other States.
b Including Montana, Oregon, Texas, Vermont, and Virginia.
c Including all products made by less than three producers in one State in order that the operations of individual establishments may not be disclosed.
d Including shale, earthenware clay, stoneware clay, paper clay, slip clay, and clay for plaster and boiler covering.
e The total of Other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Production and value of raw clay in the United States in 1898 and 1899, by States—Continued.

1898.

[Tons of 2,000 pounds.]

State.	Kaolin or china.		Ball.		Fire.		Miscellaneous.[a]		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Tons.	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Dollars.*
Alabama	50	350			11,190	7,041			7,391
California					7,000	6,800			6,800
Colorado	60	135	4,361	3,943	13,220	13,160			17,238
Connecticut	1,500	18,750							18,750
Delaware	14,958	82,286							82,286
Florida	7,200	42,000							42,000
Illinois	6,100	6,435	26,087	21,063	24,650	18,080			45,578
Indiana			11,500	11,275	13,150	21,135			32,410
Iowa			105	170	77	77			247
Kentucky	100	2,000	6,625	18,901					20,901
Maryland			292	384	1,118	1,051			1,435
Michigan	120	300	*b* 550	1,450					1,750
Missouri	1,850	6,990	1,041	21,381	19,416	210,611			238,982
Montana					854	1,462			1,462
Nebraska					7,000	2,100			2,100
New Jersey	16,234	26,811	25,113	58,884	152,840	277,113	21,456	28,064	390,872
New York	60	60	*b* 1,500	5,400	2,374	11,768			17,228
North Carolina	10,000	90,000	82	35	173	244	6	36	90,315
Ohio	300	850	20,705	11,807	24,167	19,023	2,571	3,790	35,470
Oregon					300	300			300
Pennsylvania	13,502	67,462			35,656	58,192	1,160	7,792	133,446
South Carolina	22,150	97,250			3,000	5,000	6,000	21,000	123,250
Tennessee			100	25	981	942			967
Texas					710	710			710
Vermont	1,050	7,800			100	200			8,000
Virginia			50	25	20	45			70
West Virginia					31,616	17,308			17,308
Wisconsin	5,000	47,500							47,500
United States	100,534	496,979	101,111	154,743	352,612	672,362	31,193	60,682	1,384,766

a Including flint-brick clay, flint-glass pot clay, paper clay, clay for smoking pipes, and clay for wall paper, plaster, and boiler covering.
b Including slip clay.

These tables show that New Jersey is the leading clay-producing State, mining in 1899 clay valued at $440,874, or 26.8 per cent of the total product, while in 1898 this State produced $390,872 of a total of $1,384,766, or 28.2 per cent. Missouri again held second place, with a product valued at $375,400, or 22.8 per cent, as compared with a total of $238,982 in 1898, or 17.2 per cent. Pennsylvania also held her rank of third in 1899, with a product valued at $235,068, or 14.3 per cent, as compared with $133,446, or 9.6 per cent, in 1898. South Carolina, which was fourth largest producer in 1898, was fifth in 1899, being displaced by Illinois, with a product valued at $100,049. North Carolina, which was fifth in 1898, dropped in 1899 to sixth place, with a product of $76,846, as compared with $90,315 in 1898.

IMPORTS.

In the following table will be found a statement of the clay imported into the United States in recent years:

Classified imports of clay from 1885 to 1899.

Calendar year—	Kaolin or china clay.		All other clays.						Totals.	
			Unwrought.		Wrought.		Common blue.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*		*Long tons.*		*Long tons.*	
1885	10,626	$83,722	9,736	$76,899	3,554	$29,839	....	....	23,916	$190,460
1886	16,590	123,093	13,740	113,875	1,654	20,730	....	....	31,984	257,698
1887	23,186	141,360	17,645	139,405	2,187	22,287	....	....	43,318	303,052
1888	18,150	102,050	20,604	152,694	6,832	53,245	....	....	45,586	307,989
1889	19,843	113,538	19,237	145,983	8,142	64,971	....	....	47,222	324,492
1890	29,923	270,141	21,049	155,486	2,978	29,143	....	....	53,950	454,770
1891	39,901	294,158	16,094	118,689	6,297	56,182	....	....	62,292	469,629
1892	49,168	375,175	20,132	155,047	4,551	64,818	5,172	$59,971	79,323	655,011
1893	49,713	374,469	14,949	113,029	6,090	67,280	4,304	51,889	75,056	606,658
1894	62,715	465,501	13,146	98,776	4,768	60,786	2,528	28,886	83,157	653,949
1895	75,447	531,714	18,419	125,417	5,160	60,775	3,869	40,578	102,895	758,484
1896	76,718	536,081	13,319	88,029	4,514	56,701	4,983	54,695	99,534	735,506
1897	71,938	493,431	9,405	56,264	7,839	52,232	4,562	50,954	93,744	652,881
1898	85,586	573,595	16,130	98,434	1,412	24,959	5,312	58,280	108,440	755,268
1899	92,521	615,717	19,614	118,679	1,716	31,948	9,223	106,618	123,074	872,962

It is interesting to note that the product is nearly twice as great as the imports.

CLAYS AND CLAY PRODUCTS AT THE PARIS EXPOSITION OF 1900.

By Heinrich Ries.

INTRODUCTION.

While at the Paris Exposition of 1900, Group XII, class 72, included ceramic products, still the exhibits to be found in this section in the Palais des Invalides were by no means all the clay products at the fair, and one did not appreciate the amount of material exhibited until the official catalogue was taken and all the exhibits in it traced. In addition to those in the building already referred to, many others were located in national and colonial buildings in the Palais des Industries, especially in the sections devoted to mining, structural materials, chemical industries, and education. Others were out in the open, or in small pavilions, and finally the decoration and covering of many of the buildings had to be considered, for they were indeed exhibits.

Splendid as the display was, it must have produced something of a feeling of disappointment when compared with previous exhibitions, for although the wares set out showed a distinct technical advance over previous expositions, yet they lacked general character in many lines.

The tendency at a world's fair is usually for those persons to exhibit who expect to derive some commercial advantage from it, and the clay worker is one whom this would especially affect.

France has celebrated porcelain works, fire-brick factories, pressed-brick plants, tile yards, kaolin mines, etc.; consequently with these well exhibited the foreign producer of these materials can have but little hope of gain.

The products exhibited were therefore to a large degree French ones, and, where representing other countries, were chiefly high-grade wares of unique character.

While the exhibits, when taken collectively, permitted comparative study along certain lines, they did not form a picture of the ceramic industry of the world at the present day, because so many important members were lacking, and because where a factory produced a low

and high-grade ware there was a great exposition of the latter, while the former was not to be seen. Thus we saw no English whiteware, neither was there any from the Limoges. Germany had no chemical stoneware, and very few fire bricks.

These points are discussed more at length below, where the exhibits are described by countries.

RAW MATERIALS.

It is pleasing to note that the only instructive exhibit of raw materials at the Paris Exposition was that prepared by Mr. C. F. Binns, and exhibited in the United States mineral exhibit. This consisted of a series of clay samples from many localities in the United States. Each clay was exhibited in its raw and burned condition, and attached to it was a card giving its rational analysis, and the temperature at which it was burned. Both samples of each clay were rectangular, the samples of green clay being of the same size, it was possible to see the amount of fire shrinkage at a glance.

Next to this exhibit the best series of raw materials was that of L. Meynieux & Son, of Limoges, showing the raw porcelain materials obtained in that vicinity.

Aside from these, samples of unburned clay were found in the Italian mineral exhibit, the Portuguese mineral exhibit, the Roumanian and Servian pavilions, and a few scattered specimens in private displays. In most cases they lacked data of any kind.

MACHINERY.

The United States, France, and Germany had machinery exhibits, those of France being naturally the most complete. All three countries exhibited stiff mud machines, and of these the American were of the heavier and stronger build, while the French ones were much lighter. The roofing-tile presses displayed by Germany and France were very similar and not unlike the type used at some American localities.

The French exhibit also included machines for grinding and mixing clays, represses, and machines for molding and kneading porcelain bodies. The last mentioned were from the factory of P. Faure, Limoges, and some, such as those for tempering porcelain and white earthenware mixtures, and the machines for jigging oval plates have been successfully tried in the United States.

STRUCTURAL MATERIALS.

The very lowest grades, such as common brick, are hardly looked for at an international exposition, although there were some samples of French ones. France was also the only country displaying pressed brick, although she is one of the least important producers of this grade of clay product, since there is but little call for them in French construction.

Of glazed or enameled brick France again was the sole producer, the large works of Germany, Great Britain, and the United States being unrepresented, save in one exhibit, that of the Pennsylvania Buff Brick and Tile Company. It can not be said that the French products, as far as exhibited, were equal to many of those made in other countries, either in smoothness of glaze or freedom from other imperfections. The range of colors was about the same.

The hollow bricks, so far as exhibited, presented some interesting features, especially when contrasted with the American product. There were samples from France and Italy, but none from other countries. Comparing them with American ones, it is noticed that they are of denser structure, with thinner walls, but having often a greater number of interior partitions for strength. Some are also made three-fourths meter long, to stretch from one floor girder to another, although arches of several pieces, with skew backs and key brick, are also made.

In roofing tile there were fairly good chances for comparison, as Germany, France, and Great Britain had exhibits. The prevailing type of tile now seen in European cities is the interlocking one, as it has been found that this yields the tightest form of roof, but since this requires better machinery for its manufacture, the pan tile is commonly used in the smaller towns, the product coming from local yards. It is also cheaper.

Interlocking tiles have grown greatly in favor as a roofing material, largely on account of their durability. A considerable export trade has sprung up in Great Britain and France. In the latter country especially large quantities of tiles are shipped annually from Marseilles to different ports along the Mediterranean.

While all of the interlocking tiles are usually quite hard, still they are not all vitrified. The overlap is commonly less than in the American forms, so that it takes fewer tiles per square. Red is the prevailing color, but black ones are also produced in all European factories, the color being brought about by the introduction of hydrocarbons into the kiln during the later stages of burning.

Shingle tiles are also made, but in smaller quantity than the interlocking ones, and they are often colored either by a transparent or colored glaze. This practice is more common in Germany and France than in England, but tiles of this type were displayed only in the French section. The glaze is seldom free from crazes, and the covering is more for decoration than protection against moisture.

The exhibits of Portugal, Roumania, and Spain contained a few additional samples. The United States, although containing large roofing-tile factories, was not represented, for it has no export trade.

In floor tile there was a better representation, France, Germany, England, Italy, Belgium, and the United States being represented. As far as quality is concerned it can not be said that very much differ-

ence was apparent. The tiles, whether encaustic or of solid color, are all made by the dry-press process and in essentially the same manner. The French exhibit was the most complete and showed a much greater variety of colors, especially fine work having been done in the production of large and intricate designs. As a matter of fact, however, the German floor-tile industry is fully as well developed as the French, but the only exhibitor was Lamberty, Servais & Co., of Ehrang, near Trier. The great factory of Villeroy & Boch, at Mettlach, was not represented. In the Italian section the tiles were mostly of solid colors, and at times only one-fourth inch thick.

The United States exhibit compared well with foreign ones, but its location on the floor of a main aisle, usually crowded with visitors, tended to hide it from view.

Wall tiles usually appeal to the eye more than floor tiles, for, on account of the situation in which they are put, they are not subjected to abrasive action, or even weather, as in the case of floor tiles, and consequently much greater decorative effect can be obtained, either by glazing, colors, relief, or a combination of the three.

France, Germany, Belgium, England, the United States, Holland, Spain, Roumania, Persia, and Algeria all contributed their share to this group of wares, but the products of the first five showed the greatest technical perfection. There were several patterns which were common to all, viz: (1) Plain colored, rectangular, glazed tiles, of different shades and colors, used commonly for mantels and wainscoting. (2) Rectangular tiles with relief surface, covered with colored glaze, the shadow effects dependent on the variation in the depth of the glaze. This type of tile was seen in all the European exhibits except the Spanish, and was also seen in the United States exhibit. (3) Decorated tiles, including those which are either white or colored and decorated by hand painting or printing under or over the glaze, and those which are glazed and then decorated in oil colors by hand, the design covering many tiles. The former of this group represent cheaper grades, made to some extent in Europe, and also includes those exhibited by Spain, Algeria, and Persia. In the latter case the painting is done on the burned tile, and subsequent firing is simply to fix the oil colors. There were superb examples of these in the exhibits of the Royal Berlin Porcelain Factory, the Limoges exhibits, and in the exhibit of Villeroy & Boch in the Belgian section. Such work is of high grade and requires skillful artists. Of tiles from the three countries mentioned, those of German workmanship were probably slightly better. In the United States little is done in this line.

Unique examples of tile work were the cloisonné designs referred to under the French and English exhibits. They represent a style of work but little seen thus far in the United States, and as far as the glazes were concerned the foreign ones were not perfect.

The terra cotta displayed at the exposition was somewhat different

from the material known by this name in the United States, but this was partly owing to the fact that France was the only exhibitor. The United States is probably the foremost producer of terra cotta in the world, but the product being used in home construction, it has no foreign value. Of the European countries Germany is practically the only consumer of terra cotta for exterior decoration. In France and Italy the so-called glazed terra cotta is made to some extent, and constituted a rather prominent member of the exhibit of the former country. The glazed terra cotta consisted of ornamental forms for interior construction, such as balustrading, door frames and arches, window decorations, etc.; in fact it may be looked upon as a modification of Della Robbia work seen in Italy at the present time. The product is commonly made either of calcareous or white-burning refractory clay, rather porous, and not excessively hard. This is covered with a colored glaze or enamel, the latter being sometimes rendered opaque white by tin. The French forms are mostly plain, while the Italian ones are rather highly ornamented, being often reproductions in whole or part of Luca della Robbia's designs. It is probable that this glazed terra cotta received more prominence at the exposition than was deserved by its actual use in structural work.

REFRACTORY WARES.

The extent of the French exhibits of refractory wares could not but impress one with the variety and quantity of these wares produced in France, but the dearth of exhibits from other countries prevented much comparison. Germany lacked representation in either fire bricks or glass-pot clays; England was only represented by the Glenboig refractory bricks; Belgium had some wares from two districts.

Judging from those wares to be seen the foreign refractory wares are molded of fine-grained mixtures, like those commonly produced in the United States.

There was a greater predominance of silica brick, and bauxite in some cases entered as an important constituent of both fire bricks and gas retorts. The refractory uses of this material have been hitherto disregarded in the United States, although there is an abundant supply of it, with an average greater purity than either the French or Austrian material. Recent experiments made for the Alabama geological survey have shown the high refractoriness of the material mined in that State. The objection to it in all cases is its high shrinkage, so that bauxite must be burned before mixing it with the clay.

POTTERY.

Many useful as well as ornamental forms were displayed at the Paris Exposition, it being profitable to examine those in the French section alone.

The manufacture of the lower grades of pottery is pretty well established in all portions of Europe, and the consumption of the products of any district being mostly local, representation of them was hardly looked for.

Stoneware manufacture has assumed a vastness owing to the many directions in which this type of ware is used, such as domestic, ornamental, industrial, etc.

Germany no doubt leads in the production of stoneware for domestic utensils, but does little export business in these goods.

In higher grades, such as white earthenware, there is close competition between Germany and England, France being of subordinate importance. In this branch the exhibits were lacking in all three countries; neither did the large plants of the United States have any display.

Sanitary ware is a growing industry in France, Germany, and the United States which must be watched with interest. England, although a pioneer in this class, had nothing to show. So far as the exhibits of American and French wares were concerned, the American ones showed smoother finish, but this was no indication of the density of the body, which is all-important. The French sanitary ware was made in many shapes, and decorated both under and over glaze. A departure from the usual custom was the collection of Rockingham sanitary wares shown in the Portuguese exhibits.

The demand in chemical factories for a material to resist the corrosion of acids and resist temperature changes has called forth the production of chemical stoneware made with a vitrified body and salt-glazed surface. The varied use of these goods has called for a variety of shapes and sizes. Jars, turbine wheels, tanks, spigots, condensing worms are among the numerous shapes produced. Although Germany has been and is not only producer but also exporter, still she was unrepresented. France had one good display of these goods, and among the pieces showing the possibilities of the raw material was a condensing worm 30 meters long.

Ornamental pottery.—The aim of most European pottery factories at the present time seems to be the production of something cheap and "catchy." As a jardinière manufacturer once informed the writer, quantity and cheapness were the primary considerations. This flooding of the markets—and especially the American ones—with cheap pottery has led to the development of certain branches, notably decorated white earthenware, terra cotta, and bisque ornaments and faïence. Still, in each country there are a few factories whose wares are almost above criticism, for they are constantly aiming to improve the quality and artistic merit of their goods. Chemists are employed in their mixing rooms and good talent in the decorating departments. As being in this line we may mention the Royal Berlin and Meissen

porcelain works of Germany; Villeroy and Boch of Mettlach and Louviere; the Rörstrand and Gustafsberg factories in Sweden; the Royal Copenhagen and Bing and Gröndahl works in Denmark; the several works at Limoges; and Doulton and Worcester in England, etc.

In the production of faïence the French Republic, although not the originator, is now the leader. The term covers a multitude of wares. They are all made of low or medium grade clays, which burn to red or brown color usually, but this does not matter since the body is completely covered by color, glaze, and ornamentation. Few of the faïence manufacturers, except the Italian ones, follow any definite line; indeed, the endeavors of the modeler and decorator seem to lean toward the production of oddities. In the better grades of faïence some fine effects are no doubt brought about, as in the underglaze gold work of Deck in the French section.

Cloissonné effects were seen on many wares. In some a dull enameled surface, similar to the American Grueby ware, was attempted.

The Italian faïence was the only type of historic character, the forms, designs, and colors being in many cases copied after older forms made by the Robbias or about their time.

Not a few manufacturers turned their sole attention to the so-called "reflets metalliques," or metallic reflections, the ware being covered with a glaze containing metallic oxides and then burned in a reducing fire to reduce the metals. The exhibits of Zsolnay, of Pecs, Hungary, and the Golfe Juan Pottery, of Cannes, France, were probably the best exhibits of this style of work.

It was a curious fact that in spite of the enormous quantity of white earthenware and porcelain for table use made by France, Germany, England, and the United States, there was hardly a piece to be seen at the exposition, partly because the manufacturers sent no exhibits and partly because firms making both such goods and decorated wares exhibited only the latter. In the higher grades of pottery, such as decorative porcelain for either ornamental or domestic use, Germany and France are no doubt in the lead, with England following.

The aim of each is to constantly seek new effects, new combinations of colors, forms, glaze effects, and improved quality. As a result of this, many of the more celebrated factories have given up somewhat the individuality of design that they were wont to cling to in former years.

This year there has been a curious simultaneity in the production of one type of ware in central Europe. In this the glaze of a white porcelain body is covered more or less thickly by clusters of radiating crystals of different tints, including yellow, green, delicate blue, brown, and red. In the smaller forms those exhibited by the Royal porcelain works of Berlin showed the most delicate and iridescent colors, while the National factory of Sèvres excelled in the larger forms.

The Limoges table services in porcelain were works of art and delicacy not surpassed by any other country, while in the production of ornamental effects Germany had the best display. In decorative stoneware we have to compare the Doulton factories of England with the Villeroy and Boch factories of Germany and Belgium. A choice can hardly be made between the two, for the types of adornment were rather different and showed originality in each case. In this comparison we should not leave out the Rookwood, which must, however, be treated in a similar way, since its unique character puts it beyond the reach of comparative remarks.

Development in the pottery industry must take place along two lines, viz: (1) In the perfection of bodies and mixtures which, by their proper behavior in the process of manufacture, reduce the cost of the same by permitting quicker treatment and less loss. This progression will only be felt by the public in a possible reduction of selling price. (2) The production of new "effects" designed to make any kind of ware more popular and durable and to increase its sale.

At the present day the factories of Europe find a large market for their wares not only at home, but also in the United States; and this may keep on for a time until our native industry is further developed, and along other lines than the manufacture of white earthenware and domestic stoneware. Indeed, American manufacturers would just now find it hard to compete with many imported goods, owing partly to the low price at which they are sold.

EXHIBITS OF THE VARIOUS NATIONS.

AUSTRIA.

Of the 15 exhibits from this country, practically every one contained domestic utensils or ornamental articles made of white earthenware or porcelain. The manufacturing centers chiefly represented were Carlsbad, Teplitz, and Vienna. Many of the table services were decorated in underglaze blue, with gold lines. A number of the blue and gold vases were similar to the Sèvres ware, so well known. Terracotta statuettes, painted in various colors, were also a feature of several of the exhibits.

On the whole, the Austrian exhibit was somewhat disappointing. Refractory and structural wares of all types remained unrepresented. Neither was there any exhibit of the Carlsbad kaolin, which has been of much commercial importance for years. Bauxite bricks, made near Vienna, were also lacking.

BELGIUM.

The Belgian exhibits were somewhat scattered at the exposition. The most prominent, and, indeed, one of the most interesting, was that of Boch Brothers of Louviere. This is but one of the many

localities at which this firm has factories, and each specializes in certain directions. The other branches are at Septfontaine, in Luxemburg; Schramberg, in Wurttemberg; Merzig, Wadgassen, Wallerfangen, and Mettlach, in Prussia, and at Dresden, in Saxony.

The exhibit of this Belgian factory included a series of wall tile arranged in great panels, thus permitting their being covered with a large design. Most of them were flat, but in others the design was in relief. The ornamental wares exhibited were all of either stoneware or earthenware body, ornamented at times with colored glazes. One special line was in imitation of Delft ware. Another type was the "crystal iridise" ware seen in so many exhibits.

Refractory wares were exhibited by several firms, including Société Anonyme des Terres Plastiques et Produits Réfractaires d'Andenne and Henroy, of Florette. The former produces muffles for enameling made from plastic refractory clays, mixed with burned portions of the same material; also zinc retorts and chemical stoneware, such as large acid receivers. The product of the latter consists chiefly of silica bricks and special shapes. The grains are somewhat coarse—about one sixty-fourth of an inch. Some common fire brick are, however, also turned out from this factory, and with them were also shown samples of the raw materials, viz, a black plastic fire clay, a light-colored sandy one, and three other samples.

The glass-pot clays so extensively mined in Belgium and exported even to the United States were not exhibited.

One exhibit contains several series of encaustic and common dry-pressed floor tiles, as well as salt-glazed sewer pipe.

BOSNIA.

The three exibits catalogued in the official list were all from the government school of decorative art at Saravejo, and exhibited in the Bosnian pavilion in the Rue des Nations.

Aside from these there were two series of clay products—one a set of earthenware vases made of buff burning clay and rather oriental in design, the other a set of glazed earthenware flasks of green and yellow or brown color. These were probably native work, although not labeled.

BULGARIA.

The government pavilion contained an unlabeled collection of bricks, sewer pipe, and ornamental tiles, mostly salt glazed.

They represented very fairly what is being produced in that country. Roofing tiles form the most active branch of the clay-working industry and common brick come next. Some dry-pressed brick are even made, and coarser grades of pottery.

There is very little demand for such wares, as the country is small and contains few large cities. For structural work common brick are

used and plastered over, while roofs are almost exclusively of tile, even where the rest of the house may be of wood.

CANADA.

The clay products of Canada are of comparatively little commercial importance, and therefore formed no separate exhibit at Paris. Those exhibited were a part of the provincial mineral exhibit of Ontario.

The highest grades of ware shown were dry-pressed buff and red brick from Milton, Ontario. These are made from a hard dense shale. The second exhibit of this type, viz., dry-press brick from Beamsville (made of Medina shale), reminds us that Ontario may be an active producer in this line of ware.

Some hollow brick were on exhibit, and also paving brick from Ontario Junction. Sewer pipe was not shown, although it is produced in the Province.

DENMARK.

As small a country as it is, Denmark is nevertheless of great importance in the production of ceramic wares; indeed, perhaps more so in proportion to its size than any other country on the European continent. It contains several large factories whose products have an international reputation. Much of the raw material used by them is, however, imported.

There were no exhibits of brick or other structural materials, but F. L. Schmidt & Co., of Copenhagen, had a series of machines for the preparation of clay and cement materials.

The many fire brick and paving brick works of Bornholm were not represented.

The pottery industry, which has placed Denmark near the front in the ceramic industry, had a good display. The Royal Copenhagen Porcelain Factory displayed its beautiful and familiar ware, decorated with the well-known grayish blue underglaze designs, although there were new forms and decorations. It has also done its share in the production of the iridescent crystal ware.

Bing & Gröndahl, of the same city, had a similar large display. The colors on their ware, while resembling the preceding, are darker and more pronounced, and much of the decoration is in relief. They also exhibited the iridescent crystal ware.

There was also quite a display of terra cotta objects made from the washed red burning clays of Bornholm.[1]

Somewhat different from the other Danish exhibits was one of faïence, exhibited by H. Kaehler, of Naestved. The ware was of porous body covered with a red glaze, and of rather odd forms.

Much of the terra cotta ware is painted after firing.

---

[1] See Kaolins and fire clays of Europe, Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. VI., p. 76.

FINLAND.

Only one factory had an exhibit, viz., the factory of Arabia, near Helsingfors, but the wares were so different from any others in design as to afford mental refreshment. The ordinary objects shown were majolica stoves of the usual European type.

The unique ones were porcelain table services decorated with pink flowers and green leaves, including oaks, vetches, and heather. The sprays of these plants were painted across the plates, while balanced on them were costumed peasant figures in yellow and green. There were also a set of large vases decorated in excellent imitation of brecciated marble, and a series of earthenware articles with Finnish scenes.

In the Finland building on the Rue des Nations were many pieces of amateur work exhibited by the Sociétés des Arts Industrielles des Finlandes. The decoration was mostly over glaze. Other objects whose exhibitors were unknown were earthenware vases with lead glaze.

FRANCE.

As one would naturally expect the French ceramic display was most complete. Indeed, as one entered the portion of the building reserved for it the effect was startling and bewildering. The Limoges exhibits were in a separate hall on the ground floor, and the Sèvres exhibit was a suite of rooms on the second floor, while the most of the others were grouped together in a long hall adjoining the main entrance. The exhibit included all grades from the common hand-molded soft-mud brick up to the finest specimens of the porcelain maker's art.

Besides these exhibits in the north end of the west wing of the Esplanade des Invalides, others were placed in the mining and metallurgical section, the hygiene building, army and navy section, and sections for chemical industries and education.

Comparatively little clay ware of France or any other nation was used on the exterior of the exposition buildings with the exception of the roofs, and these were liberally covered by interlocking clay tile, most of them of French manufacture. Faïence, which was so lavishly used in the exposition of 1879 for external adornment, was little in evidence at the exposition of 1900, because stucco now forms a cheaper and better substitute.

In the official catalogue France was credited with 283 exhibits, and the number from her colonies was as follows: Algeria, 13, Somali, 1; India, 2; Guiana, 2; Indo-China, 7; Madagascar, 3; Martinique, 2; Mayotta and Comoros, 2; New Caledonia, 2; Senegal, 12; Soudan, 1; Tunis, 8.

The products exhibited in the French section included clay-working machinery, common and pressed brick, roofing, encaustic and enameled

tile, common red earthenware, faïence, majolica, chemical stoneware, stoneware domestic utensils, bisque and terra-cotta statuettes, white earthenware, porcelain ornaments and table wares, refractory wares, including fire brick, gas retorts, crucibles, muffles, and various types of furnaces, kiln models, fire clays, and kaolins.

To describe the exhibits in detail would fill a volume, and consequently all that is attempted here is to touch upon the more salient features.

Taken as a whole, the feature which stood out the most prominently was the great development of faïence; indeed, France grasped the idea of its manufacture from Italy at an early period, and has steadily developed it. In porcelain she is probably equal to Germany.

Raw materials.—Of these there were comparatively few, and they were mostly kaolins. L. Meynieux & Son, of Limoges, had a small but instructive display showing the various grades of kaolin found in the Limoges district. This included the feldspathic kaolin as well as that low in clay substance. There were also specimens of quartz and feldspar, although these are not important products of that region, and the Limoges factories have to draw much of their supply from foreign sources.

The exhibit of H. P. Morane, of Vaublanc, contained kaolins from Brittany, and the Société Civile des Kaolins de Beauvoir showed samples of both raw and washed material. In no instance except the latter were any analyses given, and this was an old one quoted from Brongniart's Traité des Arts Céramiques. It gave silica, 39.91; alumina, 36.37; water, 12.94.

Machinery.—The French exhibit of clay-working machinery was the most extensive in the exposition. It included soft-mud and auger brick machines, pug mills, dry pans, rolls, represses, and roofing-tile presses. The general principle of them all was similar to the American types, but usually of lighter construction. There were a few exceptions to be noted, although they are not mentioned as improvements over American ones.

In many of the French stiff-mud machines there is no pug mill and auger behind the die, but instead a pair of rolls, whose surfaces are either plain or corrugated. The clay is first pugged in a separate pug mill and then delivered to the rolls, which force it through the die.

The smallest machines of this type were constructed to be operated by hand power, and such are used at many works, not only in France, but also in England. The cutting device consists usually of a frame bearing parallel wires, which is moved across the delivery table by means of a hollow iron ring fastened at one end of the frame and pivoted so that it revolves easily. The device is similar to that used on many machines in this country. The motion of the wires is therefore a slanting one.

The roofing-tile presses on exhibition resembled the American forms in many instances; in fact, the better types of machine in use in the United States at the present day are copied somewhat after foreign ones.

The French machines are made to operate either by hand or steam power. The former have one mold, the under portion of which slides forward on the bed holding it, while the upper portion moves in a vertical plane by means of a screw and wheel. If stiff-mud roofing tiles are to be made on this press, plaster molds are used; if dry clay, then steel molds. The capacity of such a machine is 1,500 to 2,500 tiles per day of ten hours.

The steam-power form consists essentially of a pentagonal prism, on each face of which is set a steel plate corresponding to the lower surface of the mold. The plate forming the upper surface is fastened to a plunger. The prism revolving in a horizontal axis and plunger is set in a massive steel frame. As the prism revolves successive faces are brought uppermost and toward the plunger, and with each occurrence of this a slab of clay is laid on before the plunger descends, and repressed into the shape of the tile. Such a machine has a capacity of 5,000 tiles per day of ten hours, and is specially adapted to the manufacture of interlocking tiles.

Bailly's establishment, of Nancy, exhibited a series of tube cylinders for grinding porcelain mixtures, quartz, feldspar, enamels, etc. The machine consisted of an iron cylinder revolving on a horizontal axis, the cylinder being lined with either porcelain or stoneware plates, according to the nature of the material to be ground. Flint pebbles exert the grinding action.

The following table gives the dimensions and capacity of these machines:

Dimensions of machines.

Number.	Diameter.	Inside length.	Dimensions of pulleys.	Number of turns.	Charge.	Force.
					k.	*H. p.*
1	500	450	550 by 60	50 to 60	25	¼
2	650	600	760 by 80	40 to 50	60	½
3	850	800	800 by 120	35 to 40	125	1
4	1,100	1,000	1,100 by 150	25 to 35	300	2½
5	1,400	1,250	750 by 120	20 to 28	600	4
6	1,700	1,500	1,000 by 150	15 to 20	1,000	6
7	2,000	1,750	1,250 by 200	10 to 15	2,000	8

The most important machinery exhibit in the French section was that of P. Faure, of Limoges, which contained various types of machinery for tempering and forming porcelain materials.

Chemical ware.—This included two grades, viz: Chemical porcelain and stoneware. One firm, Morlent Freres, of Bayeux, had quite a complete exhibit in this line, showing the usual series of evaporating dishes, casseroles, etc. As far as appearance went they looked equal to the German wares, and a practical test would be necessary to decide their true value. One special form was a flask with a neck 6 feet long and 2 inches in diameter.

The firm of E. Jacobs & Co. was the representative of chemical stoneware, including acid receivers, stopcocks, tubes, worms for distillation apparatus, etc.

For comparative purposes the dimensions of some of these articles are here given.

Dimensions of worms for stills.

Height of coil.	Length of tube.	Size.	Interior diameter of tube.	Price.
m.	*m.*	*m.*	*mm.*	*Francs.*
0.35	4	0.2	10	18.75
.70	12	.5	25	75
.85	15	.6	40	125
1.10	22	.65	40	225
1.50	30	.85	50	375

Diameter of tubes, straight, with flange at one end.

Length.	Interior diameter.	Price.
m.	*m.*	*Francs.*
0.25	0.03	1.50
.25	.25	8.50
1.00	.03	2.25
1.00	.25	10.00
2.50	.03	15.00
2.50	.08	30.00

Glazed stoneware wash basins, rectangular 1.25 m. long, 0.55 wide, weight 81 kilos, 120 francs. The stoneware is all salt glazed.

Sanitary ware.—The improved sanitation methods which have been introduced in Europe in the last few years have brought with them a demand for sanitary earthenware, and the French manufacturers seem to have responded rather briskly, judging from the display at the exposition, especially in the hygienic section. It can not be said, however, that the quality of the ware is fully up to the English or American, either as regards color or perfection of glaze. The glaze in several

instances lacked smoothness and freedom from crazing. The forms were closets, urinals, wash basins, sinks, and washtubs, as well as special designs for hospital use, as seen in Jacobs & Co.'s exhibit. Among the exhibitors were Pillionyt, Dupuis & Co., of Paris, and Jacobs & Co., of Paris.

Structural materials.—Pressed brick, roofing tile, and glazed tile, served for decorative purposes, as well as for exhibits. In the manufacture of structural materials the French industry is abnormally developed in certain directions, viz, in the manufacture of floor and roofing tiles. This was at once apparent to even the most casual observer, for an excellent display of dry-pressed solid color and encaustic tiles for flooring, as well as of enameled tiles for wall decoration, was made in the arcade near the entrance to the French section for pottery. While the exhibits of plain and encaustic floor tiles presented no essentially new features, still some of them set off well the possibilities of the material by the combination of various colors in large designs. One specially magnificent one was the large circular design made of encaustic tiles and forming the pavement at the entrance of the west wing of the Esplanade des Invalides. A similar one is shown on the wall of the arcade in the exhibit of Société Anonyme des Carrelages Céramiques de Paray le Monial.

The colors of the plain floor tiles are commonly red, brown, buff, gray, black, white, and blue. Many have the upper surface furrowed with shallow figures in order to give a mosaic effect.

The shapes are square, hexagonal, triangular, octagonal, and diamond. The red ones are usually the cheapest, costing about one-half of what the black and white ones do.

Among the exhibitors of plain and encaustic tile were: Société Generale des Tomettes et Céramiques de Saleme, Lacabane Fils, of Pournel; Colin-Muller, of Annenil, and Simons & Co., of Le Cateon.

Some manufacturers of glazed wall tiles have quite successfully tried the cloissonné effect, mentioned under English tiles, as it affords both relief and contrast.

Interlocking roofing tile were exhibited by a number of firms. Most of the designs overlap but slightly, either longitudinally or transversely. Pan tiles and shingle tiles were to be seen in a few exhibits, and were the forms on which glazes were put when used. The most prominent color was red, but many exhibitors also displayed black tiles. When a ridge coping is used, it is commonly molded on to the upper end of a tile, thus forming a tight joint on one side at least.

In one exhibit the wall copings, instead of being made solid, had a cross brace, connecting the two wings of the coping brick.

Hollow brick in no case formed a prominent exhibit, and where hollow forms were made for fireproof floors, the system at times was

to construct single pieces, known as hourdis, and nearly a meter in length; these were then placed transversely between the girders, the ends resting on the flanges of each.

The walls of such pieces were not over two-thirds the thickness of those commonly made in the United States.

The hollow brick are used with either iron girders or wooden beams.

Very little ornamental terra cotta was seen in the French section of the exposition. What there was consisted mostly of chimney tops, friezes, or balustrading.

A few firms, notably Gilardoni et Fils, had samples of enamel bricks of various colors on exhibition. The body of the bricks is made of fire clay, and the glazes are in most instances free from crazing.

Much clay work for interior purposes of decoration and construction is set forth under the name of glazed terra cotta. While in some cases it is made from refractory clay, still in most instances a calcareous material is used, which in burning yields a creamy white porous body on which the glaze is put and burned on at a low temperature.

This glazed terra cotta, which finds considerable favor abroad, is used for the construction of mantels, balustrades, arches over doors, etc. It is also applied in exterior work, and the pavilion of the touring club located near the Champs de Mars, as well as the exhibition pieces in the Esplanade des Invalides, were splendidly executed. The former came from the factory of Gilardoni et Fils, of Choisy le Roi, the latter from the National Factory of Sèvres.

In most of their buildings the French people confine themselves either to stucco or stone for decorative effect. They have done so for many years, and show no sign of changing to terra cotta, which finds such extensive application in other countries.

Pottery.—The opinion which the pottery exhibits of the French section might very reasonably lead one to form were that Limoges was the center of the French porcelain industry, producing wares chiefly for table use, of great thinness, high grade of finish, and beautiful decoration, notably in overglaze colors; that the national factory at Sèvres contributed large and skillfully executed porcelain wares to the French output, following no special design; that the other French factories had thrown themselves heart and soul into the production of faïence, a few choosing terra cotta and bisque ornaments as a subordinate line of work. This impression is correct to a certain degree.

France at an early period borrowed the idea of faïence production from Italy, and while attempts were made from time to time to cultivate it, still they did not succeed, as the industry lacked financial support and encouragement. It is only in the nineteenth century that this line of work has developed again. We thus find the French exhibits crowded with ornamental wares of all sorts of nameless shapes,

made usually with an earthenware body and covered with a glaze under which the decoration is put on with a lavish hand. At other times the colors are applied as a thick paste, or again, as is often the custom with jardinières, the ware is covered with a colored glaze. The great aim of the manufacturer seems to be to produce a ware at once cheap and odd, but also at times unfortunately lacking beauty.

Some forms, however, deserve mention. The faïence in T. Deck's exhibit contained many forms showing the cloissonné type of decoration, and also the application of leaf gold under the glaze, a pretty effect being caused by shading it off into other tones.

Another production seen at several points was stoneware, such as vases, burnt in a heavily reducing fire, the effect being to produce not only the somber color, but also blistering of the surface at times. In the better grades of faïence this same action was applied to wares containing metal in the glaze, notably the pottery of Golfe Juan, whose wares had a most bronze-like appearance.

Bisque figures, terra-cotta busts and statuettes, and painted terra-cotta ornaments received their share of attention.

The exhibit of the Sèvres factory occupied several rooms on the second floor. The old Sèvres blue and gold ware was nowhere in evidence, but instead the prevalent shades and colors were all light and delicate. In the first room were great vases 5 feet high, whose surface was covered by great clusters of the crystallization effect seen in so many other exhibits, the colors being mostly yellow and blue. The smaller ornamental objects were mostly of white ground with delicate blues and yellow, the ornamentation being sometimes further heightened by relief work.

Aside from this there were numerous parian figures, also some magnificent dinner services.

The Limoges factories were grouped in one room, and the exhibits represented their best efforts. The highest grade of French ware, especially in table services, was shown. In thinness and translucency they were unexcelled, and the delicate overglaze colors, applied in part by hand and in part by printing, added to their beauty. Some of the openwork effects were also especially pretty, as where the glaze spanned the openings in thin ware like a film of glass. In some sets underglaze blue and gold line work was relied on solely for decorative effect; in others were seen several colors, or in still others raised beads of paste, each covered by a film of enamel.

Although much plain white porcelain is produced at Limoges none of it was on exhibition.

Refractory wares.—There was hardly a grade or shape of refractory ware that was not included in the French section in the mining and metallurgical division.

Prominent among them were refractory bricks made of fire clay, silica, bauxite, magnesite, or mixtures of bauxite and clay, graphite crucibles, muffles, and other types of laboratory furnaces, scorifiers, gas retorts, locomotive blocks, and many special shapes.

The most extensive series of silica bricks was that displayed by P. Sourdille, of St. Sébastian les Nantes. The better grades contain from 95 to 97 per cent silica; the second grades from 92 to 95 per cent. They are largely used for the hearth of steel reverberatory furnaces.

Most of the refractory goods are molded of a finer grained mixture than is commonly used in the United States. Among the special refractory shapes were bricks for pyrite-roasting furnaces, made by E. Muller & Co., of Ivry Port. Ducouroy, of the same locality, had an exhibit of gas retorts, muffles, and assayers' furnaces, some of the muffles being made of bauxite. These were cream white in color, and quite fine grained. Some of the bricks were made of magnesite. The gas retorts were spirally ribbed on the outside.

Among the noteworthy features on Goyard's exhibit were crucibles of graphite with fire-clay lining.

Barbier & Viviez had some good shapes of furnaces for laboratory and forge work. They are for heating with fuel, aided by a blast. The smaller ones had a rotary hand blower, but the larger ones were driven by steam or electricity. One small laboratory form was constructed very much on the principle of a Deville furnace, but was rectangular in shape.

Janin Frères and Guérineau also displayed magnesite bricks and pyrite-roasting furnaces.

A form of down-draft crucible furnace was shown by Deyeux, of Liancourt, which consisted of a double-walled cylinder, the inner wall being perforated near the top. The flames pass up between the two, through the openings and down through the grate bars at the bottom of the inner wall. There was also a rectangular furnace constructed on the same principle.

The only saggers seen were in the exhibit of Louis Escoyez. They were machine made and with a rather dense body.

Several exhibits contained models and plans of larger furnaces, such as muffle kilns, biscuit kilns, etc., the forms displayed in each case being patented ones. The exhibitors of these were A. Vankerckhem and Letertre, of Petit Ivry; J. Bte. Cadet fils, of Limoges; Jules Vachey, of Paris.

GERMANY.

Taken altogether, Germany is probably the most important producer of clay products in Europe, but those shown at the exposition were restricted mostly to porcelain. Out of a listed total of 42 exhibits, 38 were pottery, 2 were roofing tiles, 1 enameled wall tile, and 1 clay-working machinery.

This was probably partly due to the fact that Germany has very little export trade with France.

There were no exhibits of raw materials. Practically all the supplies of kaolin and fire clay which Germany produces are consumed by home manufacturers.

In clay-working machinery the only exhibit was that of the firm of C. Schlickeysen, of Rixdorf. This contained various types of machinery for treating clay, viz, rolls, pug mills, auger machines, and roofing-tile presses of the type already described under France, with pentagonal cylinder, forming the lower molding surface.

The most remarkable machine in the whole display was the so-called New Grand brick press. This was a stiff-mud auger machine, having three separate dies, all discharging clay at the same time. One die was at the discharge end of the cylinder in its proper place. The other two dies were on the right and left sides of the cylinder, just back of the first. The effect of this is that the clay bars issuing from the second and third dies move in opposite directions, but both in a plane at right angles to the first. The dies are lubricated by oil, the supply coming from a box situated on top of the machine and leading to each die through two tubes. The bars are received on a cutting table and the wire bearing cutting frame is operated by hand. Automatic cutters are not used. The advantages claimed for this machine are that three different shapes can be molded at the same time. At the time of the writer's visit it was not in operation.

The display of tiles was very limited, still it contained some beautiful pieces of work.

The walls of Schlickeysen's section were lined with enameled tiles made by Lamberty, Servais & Co., of Trier. The tiles were rectangular, with white porous body and colored glaze, those forming the border being decorated in relief also.

One of the finest features of tile work in the German section was in the exhibit of Villeroy & Boch, who presented some new forms of panel tiling in green wedgewood ware. The white figures against the green ground were molded at the same time as the tile instead of being laid on separately. One large panel was 2.6 meters long and 0.5 meter wide and molded in one piece.

The exhibit of the Royal Berlin factory contained another fine piece of decorated tile work, which covered a large wall space over a mantel. The design, which was a large one, was painted on the burned tile and then fired a second time.

Both of the roofing tile exhibits were on buildings. That of Ludvici was porous interlocking red tile, and was on the building behind the Esplanade des Invalides; the other exhibit by Zinstag, of Korch, was also of interlocking tiles and formed the roof of the German building on the Rue des Nations.

The pottery exhibit included few objects aside from ornamental ones, many being cheaper grades of fancy goods displayed for sale.

The exhibits of the Royal Porcelain Works of Berlin, the Royal Saxon factory at Meissen, and of Villeroy and Boch, stood out with prominence among the others, as producers of high grades of ornamental porcelain and decorated stoneware, each possessing more or less individuality.

Aside from these, the pottery exhibits in the German section included several types. There was first much white earthenware decorated partly by hand in colors and gold, which affords a rather showy ware at low price; secondly, stoneware with metallic lustered surface; thirdly, bisque figures; and fourth, faïence resembling somewhat the French objects, but of plainer forms. At times the cloissonné style of decoration is used on it.

Several exhibitors, notably the three first mentioned, had also put forth pieces of the crystallized surface ware, one even applying it to wall tiles. The Berlin exhibit had some of the finest pieces to be seen at the exposition, with the exception of those in the Sèvres exhibit.

Common stoneware industry, refractory ware, white earthenware for table use, pressed brick, and terra cotta materials were all unrepresented at the exposition.

GREAT BRITAIN.

Of the twenty-nine exhibits credited to Great Britain in the catalogue, thirteen were from the colonies, either Canada or India.

The British exhibit as a whole gave one absolutely no conception of the clay-working industry in England, there being, for instance, but one exhibit from the great Staffordshire pottery district. Neither were any of the raw materials, such as kaolin, shown, in whose production Great Britain probably leads the world.

The large roofing tile works of H. I. & C. Major, at Bridgewater (Somersetshire), sent a series of shingle and interlocking tile for exhibition. They were either red or black, and presented no specially new features. The interlocking ones were ribbed both longitudinally and transversely.

The Farnley Iron Company, of Leeds, displayed enamel bricks, sinks, tubs, and closets. The body of all was apparently a fire clay over which the glaze is applied, and much of it was pierced by pinholes. One of the most interesting exhibits was that of the Pilkington Art Tile and Pottery Company, of Clifton Junction, near Manchester.

The tiles for wall and floor decoration are all machine made, mostly dry pressed; those for walls being glazed, the others not.

In the wall tiles the design was produced partly by relief, the balance of the decorative and artistic effect being supplied by the appli-

cation of color, or glaze, or even both. Shading was often brought out by the thickening of slightly colored glaze in the depressions. Again, the design was pressed into the surface of the tile, leaving thin ridges between the different parts of the pattern. The different colors were applied to the pattern, but the presence of the ridges kept them from running together. In addition, a strip of color was sometimes laid on the ridges, thus giving contrast and emphasis to the design, and boldly outlining it.

This method of decoration which was seen on many tiles at the exposition and also on faïence, is spoken of as "cloissonné" decoration. Portions of the wall of the exhibits were decorated by a mosaic of irregular pieces of glazed tiles set in cement. Considerable space was left between the bits, and along certain lines were set pieces having one straight side in line with others in either a vertical or horizontal direction, thus producing an effect of division into squares.

Still another effect was the production of lustrous scales within the glaze. This, however, is not a new process.

Of pottery, there were only four exhibits. The product of Doulton & Co. is too well known to need description. Sir Edmond Olton, of Clevedon, had an exhibit of faïence, and Tooth & Co. displayed a series of majolica jardinières.

One exhibit which arrested attention was that of the Belleek Pottery Works, Limited, of Fermanagh, Ireland. Most persons are not aware of the existence of a plant turning out this ware in the country where it originated. The ware, which is translucent, evidently contains much feldspar, judging from its color, and is highly glazed. The shapes are mostly very delicate, including such forms as baskets made of interwoven clay strips, and often decorated with flowers and leaves, modeled separately and then fastened on with slip.

In the mining and metallurgical building were several displays of refractory materials. None of them were listed in the catalogue. The Glenboig Fire Brick Works, of Glasgow, displayed a series of shapes. Many of these were burned in their Dunnachie regenerative kiln, of which photographs were also on exhibition.

Cary Brothers' exhibit contained silica brick and fire brick. The former were made of micaceous quartz sand and sand rock, the latter of a mixture of clay with quartz grog.

N. B. Allen & Co. had dinas, silica, and clay fire bricks. The silica bricks were of various shapes and finer grained than the French ones.

GREECE.

Greece has no clay-working industry to boast of, there being little demand for such products. The wares made in that country consist of common brick, roofing tile, and earthenware.

The national pavilion on the Rue des Nations was constructed of buff pressed brick and hollow blocks, with occasional courses of blue enamel ones for decorative effect. The roof was laid with pan tile.

HOLLAND.

This country had a modest but thoroughly characteristic series of exhibits. With the exception of glazed wall tile, they were all displays of pottery.

Prominent among these were two types, viz, white earthenware with overglaze decoration and faïence. The shapes of the former were more or less Dutch in design, and the decoration, which harmonized with the shape, consisted of thistles, birds, and cornflowers, of green and brown color. The faïence ware was of various shapes, decorated with bold green and brown designs, covered by a transparent glaze.

While the majority of faïence exhibitors follow this line, a few depart from it. In one piece the outlines of the design were cut in the clay and covered by a transparent glaze with but little color, the thickening of the glaze in the carved portions lending the necessary shading. In the Dedistel faïence the surface was covered by relief designs.

In ornamental tiles blue and white Delft designs predominated, but one series was covered by a dull enamel burned in reducing fire to give metallic luster effects.

On the whole, the Holland exhibit was one of the most notable of those seen at the exposition.

HUNGARY.

Structural products were represented by the exhibit of the Société Anonyme Hongroise de Budapest, containing red vitrified brick and floor tiles. The former were of stiff mud and repressed with rounded edges.

The characteristic wares for which Hungary is so well known were white earthenware goods for domestic and ornamental use, usually decorated with the most brilliant overglaze colors, yellow and blue flowers being prominent. Many of the pieces contained open-work designs, cut in the green clay.

Zsolnay's factory at Pecs is perhaps one of the largest in the country, and displayed a series of slip-glazed earthenware objects for garden use. The same exhibit also contains a number of vases of extreme thinness covered with a glaze burned in reducing fire, so as to give metallic reflections.

ITALY.

Italy was one of the few countries which displayed any raw materials. The Government exhibit in the Mining and Metallurgical sec-

tion included a series of raw clays and some washed kaolins. The latter appeared very white. Unfortunately there were no data concerning them.

In the machinery annex there was also a kaolin exhibit by Luigi of Turin. The kaolin, which comes from Luserna, was shown in both its crude and washed condition. There were also samples of insulators in whose construction it is probably used.

In the grounds behind the west wing of the Esplanade des Invalides there was a good exhibit of fire-proofing by Eredi Frazzi. One essential feature was the thinness of the walls of the various pieces, they being not over three-eighths inch thick. Many were similar in form to those used in the United States for the construction of flat or bent floor arches, but the individual brick commonly had a greater number of cross partitions, this being necessary to give them strength. They were also made of a finer and denser mixture than American fireproofing.

Owing to the difference which these exhibits show from American forms, it is of interest to quote the following tests furnished by the firm. The tests were made at the Polytechnicum in Munich, Bavaria:

Tests of fireproofing.

Name of piece tested.	Dimensions in centimeters.	Number of tests.	Crushing strength.	
			Of piece.	Per square meter.
Hollow brick	30 × 15 × 6	2	3,800	84,000
	14.5 × 15 × 6	2	1,925	88,000
	30 × 15 × 10	2	3,925	87,500
	14.5 × 15 × 10	3	1,925	88,500
Hourdis	70 × 25 × 7.5	3	927	5,700
	90 × 25 × 7.5	3	1,870	7,480
	90 × 25 × 10	3	4,756	19,024
	90 × 25 × 7.5	3	3,220	16,100
	100 × 20	2	5,055	25,275
	100 × 40	1	7,300	18,250
	100 × 50	2	11,445	22,890
	150 × 50	2	7,830	10,440

Floor tiles of plain color and various shapes were exhibited by G. Appiani, of Treviso. They were all made by the dry-press process. The feature of many was their thinness, as they did not exceed three-eighths of an inch in thickness.

Another exhibitor from the same locality, G. Gregori, had enameled

tiles of diverse colors and shape. The shades were good, but few showed a glaze free from pinholes.

The trend of the Italian clay-working industry was, however, shown off well in the National Building, along the Seine. Here the one branch of the Italian pottery industry which had its birth at Faenza, and has received such generous support since its beginning by the high personages of the country, was spread out in one grand display.

Italian faïence, or majolica, as it is sometimes called, was to be seen here in every shape and color that had ever been associated with it. It can not be said that the wares are always pretty, and indeed some people find absolutely nothing to admire in them. They are, however, characteristic, and many of them combined beauty and softness in the color decoration when properly applied. Their method of manufacture interferes somewhat with the production of delicate patterns.

These wares are commonly made from calcareous clays; they are burned and then the glaze applied. Before firing the latter, however, the color is applied to it and sinks into the powdery layer of unburned glaze as soon as it is painted on.

There were many exhibits of this ware in the Italian building. The shapes were more or less characteristic, and consisted of urns, vases, plates, etc. Some were decorated in varied colors. Some of the larger pieces, such as reliefs, copies of some of the Della Robbia designs, were covered in part with an opaque white tin enamel against a blue ground. Imitations of the lustered-surface gubbio ware were not wanting.

Specimens of modern porcelain work were confined chiefly to the exhibit of the Société Céramique Richard-Ginori. This firm has done much to establish the manufacture of porcelain in Italian cities on a firm basis and has succeeded well. The porcelain articles exhibited by them are tablewares, decorated with underglaze colors and overglaze gold.

LUXEMBURG.

This small duchy contains one large pottery establishment, viz, that of Villeroy & Boch, at Septfontaines. This factory turns out several grades of ware which were well shown. They consist of colored wall tiles, decorated in part by painting and partly by hand. The ground was usually buff, while the decorations were red and green or blue and bronze.

There were also terra-cotta figures in white and buff, and yellow earthenware vases with red and green decorations outlined by gilt. In addition to these there was a series of domestic wares covered with a leadless glaze and having a stoneware body. Earthenware utensils with a slip glaze of brown color were also exhibited.

MONACO.

The exhibits, which were all in the Monaco building, consisted of thin translucent wares of various colors, designated as céramique vitrié, and majolica tiles and ornaments. The latter resembled the Italian wares somewhat. Many were decorated with white figures, covered with tin enamel, against a light greenish-blue background. There were also white earthenware figures with glaze and overglaze colors.

NORWAY.

Norway had but little to exhibit, indeed much less than was shown at the Stockholm Exposition in 1897.

One exhibit, by Lerche, of Christiania, contained ornamental faïence of rather odd shapes and deep colors.

PERSIA.

At the entrance to the Persian building were two large panels, made up of glazed tile, covered with a large equestrian figure in low relief. The paneling on the sides of the building was also constructed of embossed glazed tiles. In the building a varied assortment of somewhat crude majolica vases and tiles was offered for sale.

PORTUGAL.

The Government exhibit in the mining building contained a great series of clays in wooden boxes. Labels and other information were wanting.

In the Invalides Building the Portuguese clay product exhibit was a curious mixture of all sorts of articles, all unlabeled and rather leading one to the belief that some of them were special attempts, rather than steady products. The exhibit included many bits of majolica and barbotine ware, red earthenware ornaments, glazed tiles, rockingham-ware closets, sewer pipes, slip-glazed roofing tile, and white earthenware.

ROUMANIA.

Roumania made the best display of any of the Balkan countries. The exhibit was located in the government building, and the products were mostly from the Fabrique Basaltique at Bucarest. They consisted of majolica tile stoves, sewer pipes, stoneware spigots, encaustic tiles, glazed and hollow brick, and roofing tile. This factory, which is probably the largest in the Balkan countries, is doing most creditable work, and the goods produced by it find a ready market. The clays which it uses are drawn in large part from Bulgaria, on the south side of the Danube.

In the same exhibit there were also a series of clays in bottles. These, however, represent mostly undeveloped deposits.

RUSSIA.

The natural resources of Russia are vast, and her deposits of different grades of clay are by no means unimportant. That she is beginning to utilize them is known, and was also pointed out in a previous paper (The kaolins and fire clays of Europe)[1], but the exhibits at Paris gave unfortunately but little indication of this.

Foremost among the few stood the exhibit made by the Royal factory at St. Petersburg, whose productions, though never brilliant in color, are still characterized by a beauty and gracefulness that is unsurpassed. There were few forms shown, but all were choice. One was a large dark-blue porcelain vase with deep blue and white decoration, and having on it several draped female figures in relief, the whole being covered by a glaze. The transparency of the drapery was equal to any other work. Another vase, having a form resembling a nautilus shell, was decorated in blue and green, the colors shading into each other, and the whole covered by a glaze giving the surface an opalescent luster, in which gray shaded off into white and this in turn into green.

Aside from this exhibit the only ones were some porcelain table services decorated in blue and gold, and a series of vases made of ferruginous clay and burned in a heavily reducing fire.

SERVIA.

In the government pavilion were a few specimens of kaolin in jars and some odd earthenware shapes with imperfect glaze. The exhibit gave no representation of the native industry, for many bricks are manufactured around Belgrade and even burned in continuous kilns, while slip-glazed pottery is also produced in some quantity.

SPAIN.

The official catalogue contained the names of many exhibits, but dilligent search and inquiry failed to disclose most of them.

The most prominent objects were red earthenware vases and decorated tiles for walls and mantels. These latter were smaller than those manufactured in other parts of Europe. They were all decorated over glaze in rather bright colors.

SWEDEN.

Here again the exhibits were mostly of high-grade decorative wares. Both the Rörstrand and Gustafsberg factories have a high reputation.

[1] Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. VI—Continued, pp. 377–467

The Rörstrand exhibit included a series of tile stoves, also porcelain vases, among them green ones with yellow flowers, deep black ones with large white flowers in the glaze, a number of vases with the crystallizations on the glaze, and finally a series of vases somewhat resembling the Copenhagen porcelain in color, but having the design in slight relief, although painted with underglaze colors.

The exhibit of Gustafsberg factory was in many respects similar to that shown at the Stockholm Exposition in 1897, but this factory devotes itself more to tableware than ornamental articles. Still, the exhibit contained many forms of bisque ornamental ware; also vases with earthenware body, covered with gray ground and blue ornamentation.

The large industries of stoneware, fire brick, and sewer pipe located in southwestern Sweden were not represented.

SWITZERLAND.

For many years the town of Thun, in Switzerland, has supported a pottery works whose wares possess a distinctly Swiss character. That of L. Hahn was represented by a series of earthenware vases and plaques, on which the decoration was applied as a thick paste and then glazed over. The outline of the design is sometimes first traced in the soft clay with a pointed tool. The ornamentation consists chiefly of edelweiss and Swiss scenes.

The only other Swiss exhibit was that of Gardy Freres, containing porcelain electrical supplies.

UNITED STATES.

The number of exhibits (140) listed in the catalogue is rather misleading, for closer examination shows that they represent mostly single pieces entered by individuals, but sent as parts of some general institutional or society exhibit. Aside from these the materials which are found include encaustic titles, sanitary ware, pottery, wall tile, and brickmaking machinery.

Only one machine exhibit, that of the American Clay-working Machinery Company, is credited to the United States. It contains an auger machine and machinery for preparing and tempering the clay. In comparison with other machines of the same type seen in the German and French exhibits, it was seen to be much heavier and stronger in construction.

A most interesting exhibit of raw materials was that in the United States mining section, consisting of a series of clay slabs, showing the material in its raw and burned condition, each specimen being accompanied by data giving the temperature at which it had been burned, and rational analysis. The clays were from different parts of the United States.

The floor of the main aisle in the United States section of the

Esplanade des Invalides was covered with encaustic and plain tiles from the Columbia Encaustic Tiling Company, of Indianapolis, while the wall of the Trenton Potteries Company exhibit was covered by white glazed tile from the works of the Pennsylvania Enameled Tile Company.

The display of the Trenton Potteries Company was composed of different styles of sanitary ware. They compared well with many, and were better than others seen at the exposition.

The United States manufacturer had little to gain commercially by exhibiting his clay products at the Paris Exposition. Still, it was a pity that a country whose clay production has an annual value of about $75,000,000 should have such a poor representation at this great international display.

PORTLAND CEMENT.

By Spencer B. Newberry.

PRODUCTION.

The product of Portland cement in the United States in 1899 was 5,652,266 barrels, an increase over that of 1898 of 1,959,982 barrels, or 53 per cent. This increase is nearly double that of the preceding year, and shows that the erection of new factories and the extension of those already existing are going on still more extensively than in the past. From present indications, the production in 1900 will show a still greater increase, as a great number of new enterprises are projected. The growth of the industry continues to be most marked in Lehigh County, Pennsylvania, and immediate vicinity.

The following table shows the production of Portland cement in 1898 and 1899, by States:

Production of Portland cement in the United States in 1898 and 1899.

State.	1898.			1899.		
	Number of works.	Product.	Value, not including packages.	Number of works.	Product.	Value, not including packages.
		Barrels.			*Barrels.*	
Arkansas				1	50,000	$87,500
California	1	50,000	$100,000	1	60,000	120,000
Illinois				2	53,000	79,500
Indiana	1	2,500	4,375			
Maryland	1	10,000	17,500			
Michigan	2	77,000	134,750	4	342,566	513,849
New Jersey	2	587,163	1,027,535	2	892,167	1,338,250
New Mexico				1	1,500	4,500
New York	7	554,358	970,126	7	472,386	708,579
North Dakota				1	1,700	5,100
Ohio	6	265,872	465,276	6	480,982	721,473
Pennsylvania	8	2,095,141	3,142,711	9	3,217,965	4,290,620
South Dakota	1	31,000	62,000	1	35,000	70,000
Texas	1	8,000	24,000			
Utah	1	11,250	22,500	1	45,000	135,000
Total	31	3,692,284	5,970,773	36	5,652,266	8,074,371

In the above table the figures for 1898 include the product of three factories manufacturing slag cement, a mechanical mixture of blast-furnace slag and slaked lime, sold by the manufacturers under the name of Portland cement. All authorities agree, however, that this product is not Portland cement. It has therefore been omitted from the table for 1899, and is described as slag cement in a later paragraph.

It will be seen from the above table that the manufacture of Portland cement has been resumed in Arkansas after a year of no production. Illinois appears in the field for the first time, with two factories, and will undoubtedly play an important part in the future development of the industry. One small factory in Indiana was shut down during the year, and the State shows no production. Two large factories are under construction, however, and there is no doubt that Indiana will soon be a large producer. Pennsylvania and New Jersey show, as usual, a great increase in their large production, and this region still maintains its place as the chief center of Portland-cement manufacture in America.

The relative growth of the industry in the most important producing sections during the last ten years is shown in the following table:

Development of the Portland-cement industry in the United States since 1890.

Section.	1890.			1894.		
	Number of works.	Product.	Per cent.	Number of works.	Product.	Per cent.
		Barrels.			*Barrels.*	
New York	4	65,000	19.4	4	117,275	14.7
Lehigh and Northampton counties, Pa., and Warren County, N. J.	5	201,000	60.0	7	485,329	60.8
Ohio	2	22,000	6.5	4	80,653	10.1
Michigan						
All other sections	5	47,500	14.1	9	115,500	14.4
Total	16	335,500	100.0	24	798,757	100.0

Development of the Portland-cement industry in the United States since 1890—Continued.

Section.	1898.			1899.		
	Number of works.	Product.	Per cent.	Number of works.	Product.	Per cent.
		Barrels.			*Barrels.*	
New York	7	554,358	15.0	7	472,386	8.4
Lehigh and Northampton counties, Pa., and Warren County, N. J.	9	2,674,304	72.4	11	4,110,132	72.7
Ohio	6	265,872	7.2	6	480,982	8.5
Michigan	2	77,000	2.1	4	342,566	6.1
All other sections	7	120,750	3.3	8	246,200	4.3
Total	31	3,692,284	100.0	36	5,652,266	100.0

This table shows that the Lehigh Valley region, in eastern Pennsylvania and western New Jersey, still holds its own in relative output. This region, which lies wholly within a circle 15 miles in radius, with Bethlehem as its center, is the seat of the first successful establishment for the manufacture of Portland cement in this country, and has from the first shown a larger production than all the rest of the United States combined. As explained in previous reports, this is due to the occurrence in that neighborhood of an immense deposit of clay-limestone, belonging to the Calciferous formation, which has nearly the composition of a Portland-cement mixture. There are at present 11 factories in this region, 2 of which are larger than any other works in the world. One of these factories is producing over 8,000 barrels a day, and is increasing its capacity still further. No large deposit of similar material has been found elsewhere in the United States. The Central and Western States are, however, abundantly supplied with materials equally suitable for the manufacture of Portland cement, and some localities are more advantageously situated in respect of fuel supply than the Lehigh Valley region. It is probable, therefore, that other sections will show a greater relative increase in the near future, and that the preeminent position of the Lehigh region will not always be maintained.

Referring once more to the table, we see that there has been a considerable reduction in the product of New York. This is perhaps due to the fact that the works in that State use vertical kilns almost exclusively, and that these are less favorably adapted than the rotary kiln to increase of output and economical production. The product of Ohio shows a steady and rapid growth. Michigan, which produced nothing until 1896, is rapidly taking an important place in the list. In

other sections the development of the industry has been comparatively slow, though Indiana, Illinois, and Kansas will soon contribute extensively to the total product of the country.

IMPORTS.

The imports of Portland cement in 1899 were 2,108,388 barrels, an increase of 94,570 barrels over the quantity imported in 1898. This increase may seem surprising in view of the greatly augmented domestic production, but is explained by the extraordinary activity in building operations which prevailed during the year. There is also a certain class of consumers who will have nothing but imported cement. These are chiefly foreign sidewalk masons in the smaller towns. In spite of the high quality and established reputation of the best brands of American cements, there are still a few engineers who specify imported Portland exclusively for all work done under their supervision. The high quality of several domestic brands is so fully established, and the guaranties of the manufacturers are so substantial, that this attitude can now only be characterized as narrow and unprogressive. The best grades of German cement are sold at prices which are from 50 cents to $1 a barrel higher than those of American Portland cements at least equal in quality.

The following table shows the imports, by countries, in 1897, 1898, and 1899:

Imports of cement into the United States in 1897, 1898, and 1899, by countries.

[Barrels.]

Country.	1897.	1898.	1899.
United Kingdom	344,336	241,198	199,633
Belgium	529,686	651,204	624,149
France	19,319	17,294	15,649
Germany	1,109,280	1,032,429	1,193,822
Other European countries	46,916	51,582	68,348
British North America	4,907	4,635	4,398
Other countries	36,480	15,476	2,389
Total	2,090,924	2,013,818	2,108,388

It will be noticed that the imports from Great Britain show a still further decline from those of former years. The imports from Belgium have also slightly declined, while those from Germany have increased. The quantity imported from other countries is relatively small.

RELATION OF DOMESTIC PRODUCTION TO IMPORTATION.

The amount of Portland cement consumed in the United States in 1899 exceeded that in 1898 by 1,981,012 barrels. As in the previous year, the demand in the autumn months was far greater than the supply, and much inconvenience was felt by contractors on account of the shortage. High prices were paid, in many cases, for immediate shipments, and important engineering works suffered considerable delay. The same conditions prevailed, to a less extent, in England and Germany, and, as in this country, led to the speedy establishment of many new cement factories. The following table shows the relation of production to imports in 1891, 1896, 1898, and 1899.

Comparison of the domestic production of Portland cement with the imports.

[Barrels.]

	1891.	1896.	1898.	1899.
Production in the United States	454, 813	1, 543, 023	3, 692, 284	5, 652, 266
Imports	2, 988, 313	2, 989, 597	2, 013, 818	2, 108, 388
Total	3, 443, 126	4, 532, 620	5, 706, 102	7, 760, 654
Exports		85, 486	36, 732	110, 272
Total consumption	3, 443, 126	4, 447, 134	5, 669, 370	7, 650, 382
Percentage of total consumption produced in the United States	13. 2	34. 7	65. 1	73. 9

The exports given in the above table consisted of exports of foreign cements, 29,182 barrels, and of domestic cements, 81,090 barrels; total, 110,272 barrels. It is probable that a part of the domestic cement exported was natural cement and not Portland.

The increase in the proportion of domestic cement consumed to that of foreign manufacture is a striking feature of the above table. It will be noted that only 13.2 per cent of the cement used in 1891 was of American manufacture, while in 1899 this percentage had risen to 73.9. Although imported cements will constantly play a less important part in this market, it will probably be many years before importation entirely ceases.

The following diagram shows the course of domestic production, importation, and total consumption of Portland cement in the United States in the last ten years:

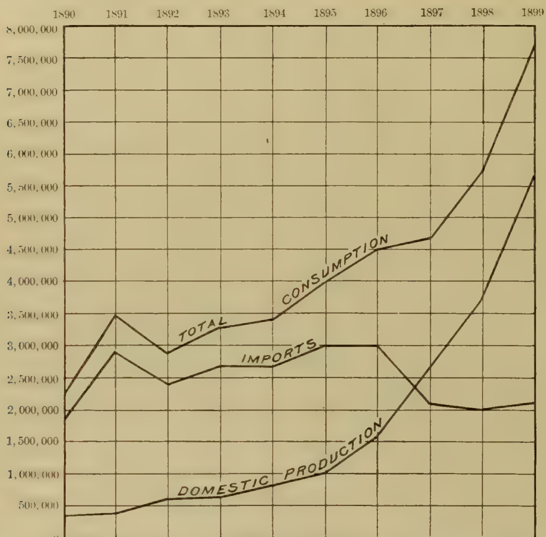

FIG. 1.—Graphic representation of the production, importation, and total consumption of Portland cement in the United States from 1890 to 1899.

This diagram shows that the imports of cement, with some variations, have remained substantially constant since 1890. The domestic product, however, which in that year amounted to only 335,500 barrels, or 15 per cent of the total amount consumed, has increased in ten years seventeen times, and now supplies nearly 74 per cent of the demand. It will be noticed that the cement manufactured in the United States in 1899 was almost exactly equal to the amount consumed in 1898, so closely does the production follow upon the heels of the demand. The regularity of the curve of production is most striking, and shows an uninterrupted increase at a constantly accelerated rate. We may well congratulate ourselves upon this rapid development of a great industry, so long as the demand keeps pace with the advance in production. It is to be feared, however, that factories are being established and extended with little consideration of the probable future condition of the market. For ten years each year has witnessed an increased consumption of Portland cement almost

exactly equal to the increased output of our factories. It is hardly to be expected that this advance in demand can continue as in the past, at constantly increasing speed. The least check in the extension of the applications of cement, or a year in which the amount used is only equal to that of the previous year, will bring about a sudden and immense overproduction, with great disaster to the smaller and less favorably situated manufacturers. Whether this will take place next year or the year following can only be conjectured; it is certain, however, that the day of keen competition among American producers is not far distant. The fall in prices which this competition will produce will stimulate the demand for the product, partly at the expense of natural cements. There is no doubt that Portland cement is at present manufactured in this country at lower cost than anywhere else in the world, and this fact, with the extent and magnitude of our engineering enterprises and public improvements, will undoubtedly develop a demand for cement far exceeding that in the countries of Europe.

The production and annual percentage of increase in the last ten years have been as follows:

Production of Portland cement, with increase each year, since 1890.

Year.	Product.	Increase.	Percentage of increase.
	Barrels.	*Barrels.*	
1890	335,500		
1891	454,813	119,313	35.6
1892	547,440	92,627	20.4
1893	590,652	43,212	7.9
1894	798,757	208,105	35.3
1895	990,324	191,567	24.0
1896	1,543,023	552,699	55.8
1897	2,677,775	1,134,752	73.5
1898	3,692,284	1,014,509	37.9
1899	5,652,266	1,959,982	53.1

The average rate of increase from year to year has been about 40 per cent. This rate continued for four more years would give an annual production of over 20,000,000 barrels, or more than the amount at present made in Germany. That the domestic product has not been restrained by limited demand is shown by the nearly constant imports since 1890. There is good reason to believe that the past rate of increase will continue for at least another year, and that the product of 1900 will reach nearly 8,000,000 barrels. Many new enterprises are projected, and existing factories are rapidly increasing their output. Most of the substantial new projects are located in the Lehigh Valley region, and that section appears likely to maintain its preeminence for some time to come. A number of companies have, how-

ever, been organized in Michigan, and that State will probably soon become an important producer. The great obstacle to the establishment of large factories in the central portion of the country is the lack of deposits of material of sufficient extent to warrant the investment of large capital. It must be apparent to everyone that the day is rapidly approaching when no factories will be profitable except those producing several thousand barrels per day. The folly of building works upon small deposits of material is therefore becoming constantly more evident.

THE PORTLAND-CEMENT INDUSTRY IN THE VARIOUS STATES.

ILLINOIS.

Two of the three factories located near La Salle were producing during the last year, and the third, that of the German-American Portland Cement Company, will be started early in 1900.

In the report of 1898 the statement was made that the Illinois Steel Company had practically discontinued the manufacture of slag cement. The writer is informed that this is an error, and that the manufacture of this product has been considerably increased. This company proposes, however, to manufacture Portland cement also, by adding to the slag the necessary amount of Bedford limestone and calcining the mixture in rotary kilns.

INDIANA.

The factories of the Sandusky Portland Cement Company at Syracuse, Kosciusko County, and the Wabash Portland Cement Company at Stroh, Lagrange County, are in process of erection, and will be put in operation early in 1900.

Works are projected at Bristol, in the northern part of the State, by the Monolith Portland Cement Company. The materials found at that point have the following composition:

Composition of Indiana marl and clay used for Portland cement.

Marl.	Per cent.	Clay.	Per cent.
Carbonate of lime	92.80	Silica	40.56
Carbonate of magnesia	2.19	Alumina	8.52
Siliceous matter	1.61	Iron oxide	2.84
Water and organic	3.58	Carbonate of lime	37.40
		Carbonate of magnesia	2.76
		Alkalies	1.97
		Water and organic	5.95
Total	100.18	Total	100

KANSAS.

Large works are under construction at Iola and will be in operation early in 1900. Limestone and clay will be used as materials and natural gas as fuel.

MICHIGAN.

The Michigan Alkali Company is regularly manufacturing Portland cement from the waste or precipitated carbonate of lime produced in causticising soda and clay. The materials are mixed and burned in rotary kilns. The analysis of the materials is as follows:

Composition of materials used for making Portland cement in Michigan.

Waste.	Per cent.	Clay.	Per cent.
Lime	50.60	Silica	46.81
Magnesia	5.35	Alumina and iron oxide	14.21
Silica	1.75	Lime	14.04
Alumina and iron oxide	0.61	Magnesia	3.61
Sulphur	0.10	Sulphur	1.18
Alkalies	0.64	Alkalies	3.04
Loss on ignition	41.70	Loss on ignition	15.75
Total	100.75	Total	98.64

Works are also under construction or projected at Jonesville, Baldwin, Newaygo, Elk Rapids, Alpena, Cementon, Fenton, and Three Rivers.

NEW JERSEY.

The Edison Portland Cement Company, at Stewartsville, Warren County, proposes to burn cement in a gigantic rotary kiln, 110 feet in length and 10 feet in diameter. The kiln has been constructed, but is not yet in operation.

NORTH DAKOTA.

The factory and deposit from which the Pembina Portland cement is made are located on Tongue River, in the Pembina Mountains. The material is a chalky clay, and geologically belongs to the Middle Cretaceous. It is soft enough to be mined by the pick, but may be wedged out in blocks weighing several hundred pounds. The material occurs in layers of varying thickness, which outcrop from a hillside. They have a total thickness of over 50 feet. Only certain of these layers are used for cement. The material is taken out by tunneling.

This marl-clay varies much in chemical composition. It is therefore necessary to observe great care in selecting and mixing the proper layers. A great number of chemical analyses are made and the essential composition of the different layers worked lies within about the following range:

Composition of marl-clay from North Dakota, used for cement manufacture.

Constituent.	Per cent.
Silica	9 to 15
Alumina	4 to 8
Iron oxide	2 to 3
Carbonate of lime	63 to 75
Carbonate of magnesia	1 to 2.5

The different layers are properly proportioned, and after being ground and mixed are burned in a rotary kiln with pulverized coal. The factory has a capacity of 125 barrels a day. The factory is located about 500 feet from the hillside from which the raw material is taken. The plant was designed by Lathbury and Spackman, of Philadelphia, and the erection was superintended by Mr. F. D. Wood.

OHIO.

The Alma Portland Cement Company, at Wellston, began operations in April, 1899. The materials are as follows:

Composition of Portland-cement materials from Wellston, Ohio.

Limestone.	Per cent.	Clay.	Per cent.
Lime	54.45	Silica	69.49
Magnesia	0.44	Alumina and iron oxide	16.42
Silica	3.53	Lime	2.29
Alumina and iron oxide	1.14	Magnesia	0.78
Loss on ignition	38.74	Loss on ignition	5.43
Total	98.30	Total	94.41

ACKNOWLEDGMENTS.

For much of the above information in regard to new enterprises and the composition of the materials employed the writer is indebted to Messrs. Lathbury & Spackman, engineers, of Philadelphia, Pa.

SLAG CEMENT.

Slag cement, made by grinding together granulated slag and slaked lime, was manufactured in 1898 at three factories, located at South Chicago, Illinois; Youngstown, Ohio; and Sparrow Point, Maryland. The total product was 233,000 barrels.

MATERIALS.

The composition of marls, limestones, and clays used or to be used at several new factories is stated on the foregoing pages. The question of the relative advantages of marl or limestone as a cement material is one which admits of much argument on both sides. Since Portland cement of good quality can be produced only by artificial mixture of the raw materials in exact proportions, it is obvious that the same result can be reached with either marl or limestone, if of suitable chemical composition. From a mechanical point of view there can be no question that a soft, fine-grained marl may be intimately mixed with the necessary clay far more easily than a hard, crystalline limestone. The drawback of marl is that deposits are usually small and scattered, necessitating irregular working and much transportation of material. Limestone possesses great advantages in extent and uniformity of deposits and in yield of cement from a given volume. A cubic yard of limestone produces about eight barrels of cement, while the same volume of marl yields only about two barrels. Limestone containing approximately the amount of clay required for a correct Portland-cement mixture is of course a very favorable material, though it is always necessary to bring it to correct composition by careful grinding, with the addition of material higher or lower in lime, as may be required. Such limestone is found in inexhaustible quantities in the Lehigh Valley region of Pennsylvania and New Jersey. This stone is generally deficient in lime, and the addition of from 10 to 25 per cent of a nearly pure limestone is necessary to give the mixture the 73 or 74 per cent of carbonate of lime required. Through the kindness of manufacturers in that region the writer is enabled to give the following typical analyses of Lehigh Valley cement rock and limestone.

Composition of Portland-cement materials in Lehigh Valley region.

	Cement rock.					Limestone, Coplay, Pa.
	Alpha, N. J.	Northampton, Pa.			Siegfried, Pa.	
		1.	2.	3.		
Calcium carbonate	70.10	69.24	63.45	67.07	68.91	94.35
Magnesium carbonate	3.96	4.21	4.56	4.06	4.28	2.18
Silica	15.05	19.06	22.22	19.08	17.32	2.14
Alumina	9.02	4.44	7.24	7.92	9.11	1.46
Iron oxide	1.27	1.14	0.92			
Total	99.40	98.09	98.39	98.13	99.62	100.13

The writer's experiments,[1] based upon those of Le Chatelier, have shown that the maximum of lime allowable in Portland cement may be represented by the following formula:

$$\text{Lime}=\text{silica}\times 2.8+\text{alumina}\times 1.1;\text{ or,}$$
$$\text{Carbonate of lime}=\text{silica}\times 5+\text{alumina}\times 2.$$

This maximum can be reached only by extremely fine grinding of the raw materials. In practice the preparation of the materials is always imperfect, and a certain part of the silica and alumina present remains inactive, as is shown by the occurrence of a small percentage of insoluble matter in all commercial cements. For this reason the proportion of carbonate of lime is usually carried about 1 to 2 per cent lower than that called for by the above formula.

As an example of a simple method of calculating cement mixtures, let us apply the formula to the Northampton cement rock No. 1 and the Coplay limestone (assuming the latter to contain 1 per cent of alumina), as follows:

Limestone.

	Per cent.
Total carbonate of lime	94.35
Silica, $2.14\times 5=10.70$ Alumina, $1.00\times 2=2.00$	12.70
Available carbonate of lime	81.65

Cement rock.

	Per cent.
Silica, $19.06\times 5=95.30$ Alumina, $4.44\times 2=8.88$	104.18
Less carbonate of lime contained	69.24
Required carbonate of lime for 100 parts cement rock	34.94

[1] Jour. Soc. Chem. Industry, November, 1897.

The number of parts limestone required for 100 parts cement rock will then be—

$$\frac{34.94 \times 100}{81.65} = 42.8$$

The per cent of carbonate of lime in the mixture will then be—

In 100 parts cement rock	69.24
In 42.8 parts limestone	40.38
In 142.8 parts mixture	109.62

$$\frac{109.62 \times 100}{142.8} = 76.7 \text{ per cent.}$$

The other samples of cement rock will give practically the same result, varying slightly with the proportion of inert materials (magnesia and iron oxide) present. In practice, from 74 to 75 per cent carbonate of lime is found to be a good working proportion.

The following table shows the comparative product from limestone and marl in 1898 and 1899:

Portland cement made with limestone and marl in 1898 and 1899.

	1898.		1899.	
	Number.	Product.	Number.	Product.
		Barrels.		*Barrels.*
Factories using limestone	20	3,112,492	24	4,697,722
Factories using marl	11	579,792	12	954,544
Total	31	3,692,284	36	5,652,266

PROCESSES.

The use of the rotary kiln for burning cement continues to increase, as may be seen by the following table:

Amount of Portland cement made in kilns of various kinds.

[Barrels.]

	1893.	1897.	1898.	1899.
Rotary kilns	149,000	1,311,319	2,170,782	3,711,220
Vertical kilns (continuous and intermittent)	441,653	1,366,456	1,521,502	1,941,046
Total	590,653	2,677,775	3,692,284	5,652,266
Per cent of total product burned in rotary kilns	25.2	49.0	58.8	65.7

In 1899, rotary kilns were in use at 20 factories, and vertical kilns at 16.

The rotary-kiln process of cement burning originated in England, having been patented by Siemens in 1869, and was first practically used by Ransome in 1885. The results at first obtained were, however, disappointing, and in spite of the evident advantages of the process the invention was dropped, apparently with little effort to discover or remove the causes of failure. The higher price of labor in the United States offered a special inducement to experiments in the direction of labor-saving machinery, and the rotary kiln was taken up in this country with most encouraging results. At present it appears destined to supplant entirely the older forms of kiln.

The rotary kiln has now again been introduced into Europe, with the benefit of improvements made and experience gained by American engineers. One has been installed by M. Candlot & Cie, at Dennemont, France; one by J. C. Gostling, and thirty-two by J. B. White & Bros., in England. In Germany, one kiln has been built at Lollar and four at Hemmoor. A full account of the results obtained at the latter factory is given in the report of the last annual meeting of the Association of German Portland Cement Manufacturers. The cement obtained is stated to be superior to that obtained from the Dietzsch kiln, and a saving in cost of manufacture of 44 pfennigs (11 cents) per barrel has already been attained. It appears probable that the use of the rotary kiln in European countries will extend no less rapidly than in the United States.

AMERICAN ROCK CEMENT.

By Uriah Cummings.

PRODUCTION.

The reports for the season of 1899 show a healthy growth in the manufacture of natural-rock cement, the output being the largest in the history of the industry in this country.

The increase in production, amounting to 1,500,000 barrels more than in 1898, was confined mostly to the States of New York and Indiana.

The extra demand was but temporary and was not accompanied by an increase in the manufacturing capacity, which is now sufficient to produce 12,000,000 barrels annually.

The following table gives the amount and value of the natural-rock cement produced in the United States during 1898 and 1899. The values are based on the price per barrel in bulk at the various factories. The cost of package is always added to the bulk price of the cement. Approximately 80 per cent of the cement is now sold in jute or paper sacks.

Product of natural-rock cement in 1898 and 1899.

State.	1898.			1899.		
	Number of works.	Product in barrels.	Value.	Number of works.	Product in barrels.	Value.
Florida	1	7,500	$7,500	1	....	....
Georgia	1	18,000	13,500	1	13,000	$9,750
Illinois	3	630,228	220,580	3	537,094	187,983
Indiana and Kentucky	19	2,040,000	816,000	19	2,922,453	1,022,858
Kansas	2	160,000	120,000	2	150,000	60,000
Maryland	4	297,475	118,989	4	362,000	144,800
Minnesota	2	128,436	64,218	2	113,986	56,793
New York	29	4,157,917	2,065,658	29	4,689,167	2,813,500

Product of natural-rock cement in 1898 and 1899—Continued.

State.	1898.			1899.		
	Number of works.	Product in barrels.	Value.	Number of works.	Product in barrels.	Value.
Ohio	3	26, 724	$13, 362	3	34, 557	$17, 279
Pennsylvania	5	499, 956	249, 978	5	511, 404	255, 702
Tennessee	1	10, 000	8, 000	1	10, 000	8, 000
Texas	1	11. 000	16, 500	1	12, 000	20, 400
Virginia	3	8, 835	5, 301	3	63, 500	38, 100
West Virginia	1	42, 874	17, 150	1	52, 727	21, 090
Wisconsin	1	379, 979	151, 992	1	396, 291	158, 516
Total	76	8, 418, 924	3, 888, 728	76	9, 868, 179	4, 814, 771

PRICES.

There was an advance of 2.6 cents per barrel over the prices for 1898, which was probably due to the increased demand.

The following table shows the average price per barrel for natural-rock cement in bulk at the mills during the last ten years.

Prices of American natural-rock cement from 1890 to 1899.

Year.	Cents per barrel.	Year.	Cents per barrel.
1890	51. 37	1895	50. 32
1891	47. 26	1896	50. 80
1892	48. 61	1897	46. 47
1893	43. 87	1898	46. 19
1894	48. 07	1899	48. 79

Average price per barrel for ten years, 48.175 cents.

When it is considered that there have been no trusts or combinations among the manufacturers of natural-rock cements, and that the capacity has been in excess of the demand, it is remarkable that the fluctuations in prices during the last ten years should have been so slight.

It proves the statement made by the writer in his report for 1898, that the prices of natural cement have been beaten down as far as it seems possible for them to go.

CONSUMPTION.

The following table shows the total number of barrels of natural and Portland cement that have been consumed in this country to January 1, 1900. The figures have been prepared after careful and

exhaustive research and will be found approximately correct, and in the absence of any other known table covering the same period may be considered authoritative:

Total consumption of cement in the United States to January 1, 1900.

[Barrels.]

Year.	Natural-rock cement.	Imported Portland.	Domestic Portland.
To 1830	300,000		
1830–40	1,000,000		
1840–50	4,250,000		
1850–60	11,000,000	23,160	
1860–70	16,420,000	21,715	
1870–80	22,000,000	748,406	82,000
1880	2,030,000	187,000	42,000
1881	2,440,000	221,000	60,000
1882	3,165,000	370,406	85,000
1883	4,190,000	486,418	90,000
1884	4,000,000	585,768	100,000
1885	4,100,000	554,396	150,000
1886	4,186,152	650,032	150,000
1887	6,692,744	1,070,400	250,000
1888	6,253,295	1,835,504	250,000
1889	6,531,876	1,740,356	300,000
1890	7,082,204	1,940,186	335,000
1891	7,451,535	2,988,313	454,813
1892	8,211,181	2,440,654	547,440
1893	7,411,815	2,674,149	590,652
1894	7,563,488	2,638,107	798,757
1895	7,741,077	2,997,395	990,324
1896	7,970,450	2,989,597	1,543,023
1897	8,311,688	2,090,924	2,677,775
1898	8,418,924	2,013,818	3,692,284
1899	9,868,179	2,108,388	5,652,266
Total	178,589,608	33,376,092	18,841,334

Total consumption, 231,378,151 barrels.

Percentage of each kind.

Natural-rock cement	77.38
Imported Portland	14.46
Domestic Portland	8.16
Total	100.00

It will be noted in this table that the growth of the natural-cement trade has been steady and uniform, until it has reached nearly 10,000,000 barrels annually.

A record of over 178,000,000 barrels, with failures so few as to be insignificant, is a record of which the manufacturers of American natural cement may well be proud. There seems to be no reasonable doubt that this healthy growth will continue indefinitely. American natural cement has a field of its own, established through eighty-two years of use in over 77 per cent of the cement masonry and concrete laid in the United States.

It is beginning to be understood that the discoveries of really first-class cement rock deposits are few and far between. The writer is aware of but one that was unearthed during 1899, and that was near Chattanooga, Tennessee. This deposit possesses some remarkable characteristics. It is of enormous thickness, the layers are singularly uniform in their proportions of clay and calcium carbonate, and the texture of the rock is exceedingly fine.

After calcination this rock shows the following analysis:

Composition of natural rock cement from Chattanooga, Tennessee.

Constituent.	Per cent.
Silica	22.17
Alumina	8.20
Lime	65.68
Magnesia	1.45
Oxide of iron	2.50
Total	100.00

This analysis corresponds to those of the best grades of Portland, and in reality the deposit is a bed of natural Portland, similar to that at Boulogne, France, although vastly superior to the latter in the matter of uniformity in the proportions of ingredients, as the deposit in France is made up of large and small pebbles and bowlders, while the Chattanooga deposit is one vast formation of heavy layers lying one upon another to the depth of over 50 feet.

Samples from this deposit were calcined to a white heat in an ordinary try kiln, with the following results in tensile strength per square inch after one day in air and six days in water:

Tests of Chattanooga cement.

	Pounds.
Briquette No. 1	573
Briquette No. 2	696
Briquette No. 3	583
Briquette No. 4	592
Briquette No. 5	637
Briquette No. 6	658
Average	623

A one-day test of one hour in air and twenty-three hours in water averaged 235 pounds. A twenty-eight-day test, one day in air and twenty-seven days in water, averaged 797 pounds.

This is undoubtedly the highest testing natural Portland cement in the world, and with cheap fuel assured (a most excellent coal mine being less than 10 miles away) there is no reason why the Southern States should not be supplied with the very finest quality of both natural and Portland cements at very much lower prices than those to which they have been accustomed.

SOAPSTONE.

By Edward W. Parker.

PRODUCTION.

The production of soapstone in the United States in 1899 was larger than that of any preceding year when measured by tonnage, but less when considered by value than that of 1894, 1896, or 1897. The product includes a variety of verd-antique from Catalina Island, California, but does not include the production of fibrous talc from St. Lawrence County, New York, which is considered separately. The quantity of the verd-antique produced in 1899 was reported in superficial feet, for which there is no equivalent in tons, and consequently does not appear in the amount of 24,765 short tons given as the total product in 1899. Its value, however, is included in the total value. The value also includes $36,000 worth of manufactured articles for which no amounts were given. If these were added, the total amount of the product would probably be between 26,000 and 27,000 short tons. The inclusion of these factors in the value, while not included in the quantity, causes an apparent advance in the average value per ton, as compared with 1898, from $11.92 to $13.36. Deducting these values from the total and reducing to an average price per ton, the value in 1899 is found to have been $11.52, or 40 cents less than in 1898. The variations in the average price per ton from year to year are more apparent than real. The value of the product is obtained from each operator in the condition in which it is first sold. Necessarily, less value per ton is obtained for the material in its rough or crude state than when sawed, ground, or manufactured. Consequently, when in one year a larger amount is sold after being wholly or partly manufactured, the total value for that year will be larger in proportion to the product than that of some other year with which it is compared, and the seeming advance in price is misleading.

In the following table is shown the production of soapstone since 1893, the quantities and values being given for the material in its first marketable condition:

Production of soapstone from 1893 to 1899.

Condition in which marketed.	1893.		1894.		1895.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Rough	5,760	$51,600	5,620	$50,780	1,041	$8,886
Sawed into slabs	104	4,400	1,303	19,500	863	12,320
Manufactured articles (*a*)	7,070	123,600	6,425	244,000	10,789	170,791
Ground (*b*)	8,137	75,467	9,796	87,045	8,802	74,498
Total (*c*)	21,071	255,067	23,144	401,325	21,495	266,495

Condition in which marketed.	1896.		1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Rough	1,550	$13,375	1,020	$12,535	1,380	$16,453	1,540	$18,800
Sawed into slabs	923	15,481	1,107	21,726	1,305	13,240	1,499	12,392
Manufactured articles (*a*)	10,133	232,261	12,095	267,583	11,336	191,923	12,377	*d* 229,310
Ground (*b*)	9,577	92,984	7,701	63,785	8,210	65,496	9,349	70,303
Total (*c*)	22,183	354,065	21,923	365,629	22,231	287,112	24,765	330,805

a Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantels, sinks griddles, slate pencils, and numerous other articles of everyday use.

b For foundry facings, paper making, lubricators, dressing skins and leather, etc.

c Exclusive of the amount used for pigment, which is included among mineral paints.

d Includes manufactured materials to the value of $40,275, for which no quantities were given.

Distributed by States, the production in 1898 and 1899 was as follows:

Production of soapstone in 1898 and 1899, by States.

State.	1898.		1899.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
Georgia	639	$4,054	1,062	*a* $42,085
North Carolina	1,695	27,320	1,817	31,880
Pennsylvania	3,778	25,436	5,012	32,872
Virginia	10,059	119,480	10,886	107,062
Other States (*b*)	6,060	110,822	5,988	*c* 116,906
Total	22,231	287,112	24,765	330,805

a Includes manufactured articles to the value of $36,000, for which no quantities were given.

b California, Maryland, Massachusetts, New Hampshire, and New Jersey.

c Includes $4,275 value, for which no quantity was reported.

In the following table are shown the amount and value of soapstone produced in the United States since 1880, exclusive of soapstone ground for paint and fibrous talc.

Annual product of soapstone since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	8,441	$66,665	1890	13,670	$252,309
1881	7,000	75,000	1891	16,514	243,981
1882	6,000	90,000	1892	23,208	423,449
1883	8,000	150,000	1893	21,071	255,067
1884	10,000	200,000	1894	23,144	401,325
1885	10,000	200,000	1895	21,495	266,495
1886	12,000	225,000	1896	22,183	354,065
1887	12,000	225,000	1897	21,923	365,629
1888	15,000	250,000	1898	22,231	287,112
1889	12,715	231,708	1899	24,765	330,805

FIBROUS TALC.

The production of fibrous talc in 1899 was somewhat larger, both in quantity and value, than it was in 1898. There was, however, one previous year in the history of the industry when the amount produced was greater and two years when the value exceeded that of 1899. The product last year was 54,655 short tons. This was exceeded in 1897, when the output was a little over 50,000 tons. The value of the 1899 product was $438,150, which was exceeded in 1891 and 1892, the figures in those years being $493,068 and $472,485, respectively.

Gouverneur, St. Lawrence County, New York, continues to be the only source of supply for this peculiar variety of soapstone or talc. It is used to some extent by manufacturers of paint and wall plasters, but its chief use is as a makeweight in the manufacture of intermediate grades of paper. It is not used in either the very common nor the finer grades. Prices improved somewhat in 1899, as compared with 1897 and 1898, the averages being, respectively: 1897, $7.95; 1898, $7.61; 1899, $8.02.

The following table shows the amount and value of fibrous talc produced in the United States since 1895:

Disposition of fibrous talc produced since 1895.

	1895.		1896.		1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*		*Short tons.*	
Sold crude			1,363	$2,726	9,800	$21,500	500	$1,250	500	$1,250
Paper filling	39,021	$369,007								
Paint	48	552	44,726	396,717	47,209	375,436	53,856	410,180	54,155	436,900
Wall plasters	171	1,338								
Total	39,240	370,897	46,089	399,443	57,009	396,936	54,356	411,430	54,655	438,150

The development of the fibrous talc industry since 1880 is graphically exhibited in the following table. It also shows that the product in 1899 was the largest on record except that of 1897, and that the value of the product in 1899 was less than that of the smaller production in 1891 and 1892.

Production of fibrous talc since 1880.

Year.	Quantity.	Value.
	Short tons.	
1880	4,210	$54,730
1881	5,000	60,000
1882	6,000	75,000
1883	6,000	75,000
1884	10,000	110,000
1885	10,000	110,000
1886	12,000	125,000
1887	15,000	160,000
1888	20,000	210,000
1889	23,746	244,170
1890	41,354	389,196
1891	53,054	493,068
1892	41,925	472,485
1893	35,861	403,436
1894	39,906	435,060
1895	39,240	370,897
1896	46,089	399,443
1897	57,009	396,936
1898	54,356	411,430
1899	54,655	438,150

IMPORTS.

The following table exhibits the imports of talc of all kinds since 1880. From 1880 to 1889 the imports were fairly regular. Since 1889 they have been very irregular. From 19,229 short tons, valued at $30,993, in 1889, they dropped to 1,044 tons, worth $1,560, in 1890, and 81 tons, worth $1,121, in 1891. They increased in 1892 to 531 tons and again in 1893 to 1,360 tons, decreasing in 1894 to 622 tons. In 1895 they increased to 3,165 short tons, valued at $26,843, decreasing in 1896 to 1,966 tons, worth $18,693, and again in 1897 to 796 tons, worth $8,425. In 1898 the imports amounted to 761 short tons, valued at $9,338. The imports in 1899 dropped to 254 tons, valued at $3,544, the amount being the smallest recorded with one exception, and the value was the smallest on record with two exceptions.

Talc imported into the United States from 1880 to 1899, inclusive.

Year.	Quantity.(a)	Value.	Year.	Quantity.	Value.
	Short tons.			Short tons.	
1880		$22,807	1890	1,044	$1,560
1881		7,331	1891	81	1,121
1882		25,641	1892	531	5,546
1883		14,607	1893	1,360	12,825
1884		41,165	1894	622	6,815
1885		24,356	1895	3,165	26,843
1886		24,514	1896	1,966	18,693
1887		49,250	1897	796	8,423
1888	24,165	22,446	1898	761	9,338
1889	19,229	30,993	1899	254	3,544

a Quantity not reported previous to 1888.

CANADIAN PRODUCTION.

In the following table is shown the output of soapstone in Canada for a period of fourteen years. It will be observed that the values are usually much less than those given for the United States product, and the fluctuations in value are even more pronounced than in this country. In 1886 and 1887 the product was valued at $8 per ton. The output in both years was small. In 1888, with an increase of only 40 tons in product, the value fell to $2 per ton. In 1889 the output increased 55 tons, and the price went up to $6 per ton. In 1890 the output increased to 917 tons, nearly five times the amount obtained in 1889, but the value increased only $69, the price per ton declining to $1.35. No output was reported in 1891. In 1892 the product was 50 per cent more than in 1890, the value increasing five times, or to $4.54 per ton. In

1893, with a decrease of nearly 50 per cent in the product, there was a decline to $2.68 per ton. The price declined again in 1894 to $1.78 per ton, and in 1895 advanced to $4.50 per ton, the output of 475 tons being valued at $2,138. In 1896 the production fell off 65 tons to 410 tons, while the price declined to $3 per ton, and dropped to 157 tons in 1897, and the price declined to $2.27. No output has been reported for 1898, but in 1899 a product of 450 tons was obtained.

These figures are obtained from the annual report of the Canadian Geological Survey:

Production of soapstone in Canada from 1886 to 1899.

Calendar year.	Tons.	Value.
1886	50	$400
1887	100	800
1888	140	280
1889	195	1,170
1890	917	1,239
1891	*None.*	*None.*
1892	1,374	6,240
1893	717	1,920
1894	916	1,640
1895	475	2,138
1896	410	1,230
1897	157	350
1898	*None.*	*None.*
1899	450	1,960

PRECIOUS STONES.

By George F. Kunz.

INTRODUCTION.

Among the principal items of interest relating to the production of gems in 1899 may be mentioned a general development of, and increased output from, the Yogo Valley sapphire mines in Fergus County, Montana, and the finding of a fine blue stone that afforded gems up to 4 carats in weight; also the discovery of remarkably brilliant sapphires—green, blue, pink, yellow, and brown—in many shades and tints, in Granite County, Montana; the continued output of turquoise from the mines in Grant County, New Mexico; the reopening of the turquoise property near Santa Fe, New Mexico; the development of the turquoise localities in Nevada and California; a great advance in the price of emeralds and pearls; a decided increase in the price of all qualities of cut diamonds; a great increase in the amount of diamond cutting, especially of the finer qualities, in the United States, although this industry was materially affected because of the advance in prices during the latter part of the year; and, lastly, in general, a continued search for minor gems in North Carolina, Maine, Connecticut, and other States.

DIAMOND.

UNITED STATES.

Much interest has been manifested in an important paper by Prof. W. H. Hobbs, entitled "The diamond field of the Great Lakes,[1]" which has appeared in the Popular Science Monthly. The whole history of the remarkable discovery of diamonds at various points along the line of the terminal moraine of the later ice sheet is here summarized and discussed. These successive discoveries have been noted in the Mineral Resources reports, as they have been announced from year to year since 1890; and the entire ground has been covered by the observations and studies of Professor Hobbs and the writer. The article referred to describes the seventeen diamonds from the morainal belt in

[1] Jour. of Geol., Vol. VII, No. 4, May-June, 1899.

Wisconsin, Michigan, and, lately, Ohio, in addition to which are descriptions of several very minute stones from the Plum Creek, Wisconsin, locality. The Ohio discovery, briefly mentioned in this report for last year, is a pure and brilliant stone of six carats, found in 1897 at Milford, Clermont County, by two little daughters of Mr. J. R. Taylor. It is now the property of Mr. Herman Keck, of Cincinnati, and has been cut into a handsome gem. The others are nearly all preserved as found.

Several of these diamonds remained for years in the possession of farmers, who had accidentally come upon them and who kept them as curiosities, having no idea of their nature or value. Professor Hobbs believes that probably a number of others are still lying unsuspected among the little collections of pebbles and local "curios" which accumulate on the clock shelves of country farmhouses; and he is trying, by means of notices sent to the people throughout the regions of the morainal belt, to bring to light any that may still be unrecognized and to arouse interest and stimulate search for other diamonds.

The physical characters of the stones are discussed in detail. In size they vary from the microscopic diamonds of Plum Creek to the 21-carat stone found at Kohlsville, Wisconsin. The average weight is 6 carats; but Professor Hobbs observes that this can not be taken as a true average, "since only the larger stones are likely to be discovered until a systematic search is undertaken." At Plum Creek, where the diamonds were found in panning a stream gravel, all were small (none over 2 carats), most of them very minute.

The crystalline forms are of interest, especially the rhombic dodecahedron from Oregon, Wisconsin, and those with faces of the hexoctahedron from Eagle and Kohlsville, Wisconsin, and Dowagiac, Michigan.

The stones from Saukville and Burlington, Wisconsin, are trisoctrahedral and tetrahedral, respectively, and that from Ohio, now cut, was reported as an octahedron. All are more or less rounded and distorted, and a few show twinning.

In color the stones are white to pale yellow, or with a greenish tinge, probably, as is often the case, superficial. They are generally transparent, the degree of transparency varying.

The most interesting facts, however, in connection with these diamonds concern their distribution and source. They have been found at eight localities, scattered through a region some 600 miles in length and 200 miles in breadth, and extending from Plum Creek, Wisconsin, to Milford, Ohio, almost exactly from northwest to southeast. Six of the localities are close together, within an area about 200 miles square, near the center of which is the city of Milwaukee, and about equally distant from the two extremes named.

It was soon recognized that these localities bore a close relation to

the moraine of the later ice sheet. Most of the stones were found in glacial deposits on the line of the actual terminal moraine. The one from Dowagiac, Michigan, was found on a moraine of recession, somewhat behind the terminal one. Those from Plum Creek were found in stream gravel a little outside the moraine, but evidently washed out of it. The relations of the localities to the moraines are shown in a map prepared by Professor Hobbs from data furnished by Chamberlin, Leverett, Todd, and others, to whom reference is made in the paper. The next step is, of course, to endeavor to locate the unknown source by correlation of the glacial striæ over this region and northward. The striæ are plotted on this map and on another one from the works of the aforementioned glacialists and others, including in Canada Messrs. Upham, Bell, McInnes, and Low. The general result is that the striæ of the diamond region are found to converge toward a point somewhere in the almost unexplored wilderness east of James Bay, near the district assigned by Low and Tyrrell as the approximate center of movement of their Laurentide or Labradorean ice sheet.

Professor Hobbs, in discussing the conditions of the diamond occurrence, advances two theories: (1) That the stones had been removed from their matrix by preglacial erosion, and were gathered up and transported by the ice, with other loose material; or (2) that they had been carried in pieces of their matrix, and that the latter had been abraded and broken up during the earlier stages of the ice advance, and the diamonds thus freed for separate transportation in the latter stages. Professor Hobbs inclines toward the former view, and quotes a letter from Professor Chamberlin to the same purport.

As to the original locality, the question arises whether there may be more than one. On general principles this is hardly deemed probable, for diamonds in quantity are of rare occurrence, and the number at the source or sources must have been considerable. "It is likely," says Professor Hobbs, "that for every diamond that has been found there are a thousand still undiscovered in the drift." Yet, as in Africa, there may be a district in which several diamantiferous outcrops may occur, yielding stones that differ to some extent from one another. The Oregon, Eagle, and Kohlsville stones are closely alike; the others differ somewhat in form and character. The width of the fan of distribution would indicate, if the source be one, or several near together, that it must lie far up toward the center of the glacial movement.

For the further determination of these interesting points several lines of investigation are needful. In the first place, much work is necessary upon the direction of striæ in the wilderness south of Hudson Bay, both to the east and to the west. It is also important to search the moraine line farther eastward—that is, in Ohio, New York, and Pennsylvania—in order to ascertain whether any diamonds can be

found there, and to determine the limits of the fan of distribution. Should this be found to extend farther east, "the apex * * * would seem to be located very near the center of the Labradorean névé." In his inquiry Professor Hobbs is seeking to enlist the cooperation of all geologists living near or working along the morainal border.

It is of interest here to recall the fact, which at the time had no peculiar significance, that in 1890[1] the writer made reference to two diamonds which had been exhibited for some time in Indianapolis and which were said to have been found in Indiana. They are described as elongated hexoctahedrons—the Plum Creek and Dowagiac form—of 2 carats each; but no particulars regarding their occurrence were known. It would appear that these two stones came from some point about midway in the long interval between the Milwaukee-Dowagiac central area and the solitary occurrence in Ohio.

It is worth while, in this connection, to refer to the distribution of the diamond localities of Brazil, which occur at several distant points along the Serra do Espinhaço, and are believed by some experts to form part of a diamantiferous belt following the crest of that range for several hundred miles. If such a condition existed in the Laurentide highlands, the crossing by an ice sheet might easily distribute diamonds from several distinct sources throughout a long stretch of terminal moraine.

Tennessee.—The first record of the finding of a diamond in the State of Tennessee was made by Mr. Charles Waller, of Union Crossroads, Roane County. The stone is perfectly white and flawless, and weighed originally 3 carats. It was found in close proximity to an Indian mound on the south bank of the Clinch River, Roane County, in a very slaty soil. Unfortunately, it was cut in New York before it was shown to the writer, so that no detailed description of the crystal is possible. Mr. H. W. Curtis bought the stone from Mr. Waller, and after having it cut, when it weighed 1¼ carats, he sold it to Mr. E. J. Sanford, of Knoxville, Tennessee, for $150.

California.—A paper on The Occurrence and Origin of Diamonds in California, by Mr. H. W. Turner, of Washington, was published (by permission of the Director of the United States Geological Survey) last year.[2] In this article Mr. Turner brings together and summarizes the discoveries of diamonds in the auriferous gravels of California, as described, at different times, by Prof. J. D. Whitney, Prof. Henry C. Hanks, and the writer, together with a few recent additions. These last, however, are neither numerous nor important, for the general use of stamp mills destroys the diamonds that may exist in the hardpan gravel, and their presence is revealed only by fragments found in

[1] Gems and Precious Stones of North America, p. 34.
[2] Am. Geologist, Vol. XXIII, March, 1899.

the sluices and tailings. A number of localities are noted in Amador, Butte, Del Norte, Eldorado, Nevada, Plumas, and Trinity counties. Of these, Butte County, in the neighborhood of Cherokee Flat, and Eldorado County, near Placerville, have yielded a considerable number. Plumas County is a new locality, from which Mr. J. A. Edman recently reports the finding of some small diamonds, occurring in sands, at Gopher Hill and on Upper Spanish Creek. Most of the California diamonds are of small size; some have been cut, but many are held by the finders in their natural state. One, from Cherokee, is said to be valued at $250; another is in the State Museum of Mineralogy. In a recent letter to the writer Mr. George W. Kimble, of Placerville, states that there are ten or twelve crystals in the possession of persons living in and near that place, which are valued by the finders at from $50 to $200 each.

In his paper Mr. Turner refers to the African occurrence, and seeks to trace a possible source for the California diamonds in the serpentine rocks of the Sierra Nevada. In the maps of the gold belt, published by the United States Geological Survey, he notes the occurrence of serpentine masses in the vicinity of all the diamond localities reported; and though the rock itself does not appear in the gulches near Placerville, he cites Mr. Kimble as stating that serpentine pebbles are frequent there in the diamond-bearing gravel, and are probably derived from an outcrop 4 or 5 miles to the east. Mr. Turner suggests that a careful search in the local gravels of gulches lying in the serpentines may furnish a clue to the source of the diamonds scattered through the Tertiary gold gravels.

The remainder of Mr. Turner's paper is a summary and discussion of recent views as to the origin of the South African diamonds, as presented by Messrs. De Launay, H. C. Lewis, and William Crookes, and by Professor Derby in his article—reviewed in this report for last year[1]—on the modes of diamond occurrence in Brazil.

A specimen found last summer in a Tertiary gravel deposit at Nelson Point, Plumas County, California, by Mr. F. C. Mandeville, weighed about 2 carats and is valued at $75. It was determined and valued by Mr. A. W. Lord, jeweler, Quincy, California, and reported by Mr. J. A. Edman.

AUSTRALIA.

Australian Diamond Fields, Limited.—The company known as the Australian Diamond Fields, Limited, whose mines are adjacent to those of the Inverell company, has acquired a tract of land comprising 509 acres, which is thought to be highly promising. Only a few acres, however, have as yet been worked, and it appears that the

[1] Twentieth Ann. Rept. U. S. Geol. Survey, Part VI (Continued), p. 562.

paying wash dirt is not continuous, but lies in patches and streaks. In view of these facts some disappointment was felt at the annual meeting of the stockholders of the company, but it was pointed out that only a small fraction of the deposit had been tested, and that there was room for large and profitable developments to be made, besides the fact that there were associated tin deposits. The latest reports give an account of eight loads of wash dirt, yielding 132 carats of diamonds—one of the largest averages yet attained. About £2,000 had been received during the year—£200 being for tin and nearly £700 from share dealings. If the output should continue sufficient to develop the property more extensively, it was thought that it would prove very valuable.

Bingara.—The Bingara and Inverell diamond regions of New South Wales, to which references have been made in previous reports,[1] have been continuously worked and explored. A paper read by Mr. H. M. Porter, in 1898, before the Institute of Mining and Metallurgy of New South Wales, gives the results of some recent examinations, together with various data bearing on the mode of occurrence and the production. The conditions are as described in the reports for 1895 and 1896, already mentioned, viz, a region of granite traversed by a belt of Carboniferous shale, and covered at intervals by a gravelly drift containing diamonds and tin, while an outflow of basalt overlies a considerable portion of the whole. Mr. Porter calls attention to the fact that in the region examined by him, the Boggy Camp district in the valley of the Gwydir River and its tributaries, some 10 miles southwest of Inverell and 30 miles east of Bingara, no diamonds are found in the tin-bearing drift beneath the basalt until the western edge of the Carboniferous belt has been passed. This belt has a NNW.-SSE. course across the upper tributaries of the Gwydir, whose general flow is westward, with the slope of the region, which is about 30 feet to the mile. After the Carboniferous belt has been crossed, diamonds are at once found in the patches and areas of the old river drift. Mr. Porter maintains, therefore, that their source must be at or near the line of contact of the Carboniferous and the granite; he has traced it to apparently within a limit of a half mile, or to the deposit that yields diamonds in so great abundance, viz, at Daisey's mine, just west of the contact line; none occurring at that distance northeast of it, although the other associated minerals are present. Fifty loads were tested for this determination. Daisey's mine, moreover, which is close to the contact, is by far the richest of the district, and Mr. Porter regards it as doubtless very near the source. What connection there may be with the basalt is not yet clear, save that it has protected the old river gravels from later erosion, somewhat as in

[1] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), p. 900; Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), p. 1188.

California. The upper stratum of the drift is sometimes covered with a conglomerate in which diamonds occur. Some have regarded this as a distinct rock, but Mr. Porter believes it to be simply a result of the overflow of the basalt cementing and compacting the gravel.

With regard to the diamonds themselves, the crystals are not large, their size usually ranging from one-sixteenth of a carat to 3 carats. One of between 6 and 7 carets has lately been found at the Star mine; fragments of larger stones also occur, one that was found indicating about 15 carets. Mr. Porter makes the surprising statement that large stones have not been looked for, the gratings used having only ¼-inch mesh, and all the lumps of dirt and cement above that size being thrown out on the dumps without examination, and the material is either washed away by freshets or covered with more débris. The diamonds found are of all colors and shades; in form they are chiefly octahedral. It is estimated that about 20,000 carats have thus far been obtained at Boggy Camp.

BRAZIL.

In the United States Consular Reports, May 12, 1899, a very full account is given by Mr. Thomas C. Dawson, secretary of the American legation to Brazil, of the diamond and gold mines of the State of Minas Geraes, based on a recent visit of inspection. This great State, the most populous in Brazil—population, 3,000,000 to 4,000,000—and the richest in mineral treasures, covers an area of 220,000 square miles of elevated plateau, possesses a climate which is healthful and agreeable throughout the entire year, and is full of agricultural and mining resources both present and prospective.

The diamond region has its center at Diamantina, a town with about 5,000 inhabitants, 680 miles from Rio de Janeiro. It was founded as a gold-miners' camp late in the seventeenth century, and in 1729 diamonds were discovered there. The Portuguese Government at once claimed the stones, and for about a hundred years diamond mining was a royal monopoly, until, in 1832, the Brazilian Government legalized private mining. Prior to that date the superintendents and contractors used negro slaves to work the mines, and the careless and wasteful methods employed have hopelessly covered with débris great areas of diamond-bearing gravels.

Six diamond regions exist in Brazil, viz: (1) Diamantina; (2) Grão Magor, 150 miles to the north; (3) Bagagem, a less important district 200 miles to the southwest, although here the celebrated Star of the South diamond was found in 1853, and the region is but imperfectly explored; (4) Chapada Diamantina, in the State of Bahia, noted for its black carbons; (5) Goyãz, and (6) Matto Grosso, in the States of those names, respectively.

Diamantina, Grão Magor, and Chapada are on or near the crest of the Serra do Espinhaço, or its continuations, which form the divide

between the great São Francisco River and the streams that flow to the coast between Rio and Bahia. Some experts are of the opinion that all these localities belong to a diamantiferous belt following along the crest of the serra for perhaps 500 miles.

There are four methods of working. The simplest is that pursued in the small, steep stream valleys, with rocky sides, well up on the slopes of the serra. Their beds are full of bowlders, and between these is the diamond-gravel known as the *formação*, which is easily recognized by the native prospector from certain minerals always supposed to be associated with the diamonds. Among them are gold, rutile, specular iron, tourmaline, and disthene (cyanite). The formação is dug out in the dry season, piled near the stream, and washed when the rains come. The washing is done first in a shallow excavation, a yard or so in area and a few inches deep, near the bank; the heavier and smaller stones are then further washed in a batea—a wooden dish perhaps 30 inches in diameter. The concentrates are put into the batea, with water, and it is then shaken and whirled, the lighter gravel being separated by a sort of centrifugal process and swept over the edge. The remaining gravel is finally hand picked, and the diamonds (if any) are taken out. The batea process requires much skill; it is similar to gold-panning, but the lower density of diamonds renders them more liable to be lost than gold. This method is the one generally used by the natives in both diamond and gold mining. The small stream workings are not now of much importance, having been largely exhausted by generations of gold and diamond seekers. Those who work them have usually little or no capital, and generally form small parties, who take their chances of finding virgin spots.

The second, and principal, method is practiced in the larger stream beds, and requires considerable outlay and a large number of men. When the dry season opens, a portion of a river bed that is supposed, from documents or tradition, to be virgin ground is chosen. Above it is built a rough dam, and the water of the stream is conducted around it by a sluiceway. The exposed bed is then seen to consist of sand, much of it from old workings, which has to be removed down to the formação layer, which lies on the bed rock perhaps 30 or 40 feet below the surface. The removal is effected by means of wooden pans, holding about a shovelful each, carried on the heads of negroes—a slow and costly process. Attempts have been made to introduce carts and wheelbarrows, but without success, owing to the native conservatism. The work must be prosecuted rapidly, for the first heavy rains of the autumn wash away the dam and fill the great excavation. The water that enters during the working time is removed by pumps, operated by overshot wheels run by water from the sluiceway. Mr. Dawson gives an interesting account of the rude native pumps, etc. No metal is used in their construction, the joints are mortised or bound with vines,

and there is no idea of definite measurements, all being done by the eye. Yet the pumps are adequate and successful for ordinary operations, not, however, for any special or novel conditions, such as sometimes arise, and of which he cites some instances. The formação gravel, when reached, is taken out, piled on the banks, and washed when the rainy season comes. The result is extremely uncertain, for it may have been worked at some earlier time, in which case little or nothing is obtained. If not previously worked the yield is valuable. Much of the valley of the Jequitinhonha, the principle diamond-bearing river, has been worked at some time during the last two centuries from its source to Mendanha. Below that point the valley is too wide for such operations. This river-bed mining is conducted by local native companies, no foreign capital being engaged in it.

The third method deals with the *gupiaras*—small gravel deposits on the slopes or sides of the valleys, like the "hill wash" of the Burmese ruby mines. These spots, often only a few acres in area, are casually discovered and soon worked out, but are often exceedingly rich. Over 160,000 carats of diamonds were taken in one season from a single gupiara of only 6 acres.

The fourth method is pursued high up on the serra, where the diamonds occur in conglomerates and clays—the sources whence they have been carried down into the valleys by erosion. The rocks are far less rich than the stream beds, in which there has been a natural process of concentration; but there is much more of the material accessible. Some of them are soft and easily washed, but many are harder and less workable. After getting what diamonds they could from the softer-weathered portions, the Brazilians have tried to work the deeper deposits, when not too hard, by a sort of miniature hydraulic process. Rain water is collected in pools on the tops of the plateaus, and by means of a ditch is led to a promising outcrop, where it is made to wash gullies in the rock. An artificial formação is thus produced, which is treated like the stream gravel. This method is very limited and slow, because it is impossible to collect sufficient water to do anything effective for more than a few days in the year—perhaps ten, as an average—and in some seasons no work at all can be done. Still, fortunes have been made from these chapada mines, and some of them have been worked in this scanty fashion for nearly a hundred years.

A company composed of French capitalists and known as the Companhia de Boa Vista is now about to undertake work of this kind on a great scale and with thoroughly scientific appliances. They have purchased a large tract of plateau, or chapada, of diamantiferous conglomerate, partially worked as above described, near Diamantina. Their director is Mr. Lavandeyra, an American citizen born in Cuba, a graduate of Rensselaer Polytechnic Institute, and at one time engaged on the Panama Canal. He has met and overcome extreme

difficulties, requiring novel methods in both design and application. The result is a plant of the most modern construction, consisting of two large reservoirs, at and near the top of the chapada, for washing, and pumps operated by electric motors connected by wires with a dynamo station a thousand feet lower where water power is obtained from the Santa Maria River, the water being carried in a 20-inch pipe for over a mile, with a fall of 340 feet. The washing machinery was made in Europe; the electrical machinery in America. All had to be transported in ox carts or on mules over a hundred miles of mountain trails, and repairs and adjustments had to be provided for in a country where horseshoeing is the limit of metallurgical skill. The natives are very incredulous as to the enterprise; but it can hardly fail to be highly profitable if the conglomerate rock is anywhere near as rich as there is reason to suppose. This is the first step in the introduction of modern scientific methods in the Brazilian diamond country, and if it proves successful it will surely be followed by many others.

The crystals obtained are generally sold by the finders to purchasers who frequent the neighboring villages, though many are taken to Diamantina and sold to regular dealers there. The prices vary widely, not only with the size and quality of the stones, but with fluctuations of the currency, and also with the needs of the seller. Ten dollars a carat (70 milreis) may be taken as an average. The exported gems usually go to Paris or London, none coming direct to the United States, although this is the largest diamond-purchasing country in the world and consumes almost half of the African product. Mr. Dawson thinks that American diamond buyers might better go to Brazil than to Europe for their purchases. The Brazilian stones generally have a higher value than the African, being whiter and commanding one-half more in price; colored diamonds also occur, the rose, blue, and wine colored being highly prized.

Regarding the amount produced, the lack of statistics renders it very difficult to ascertain. The buyers are, and always have been, so numerous and so scattered that no records can be had, and all published statements are merely rough estimates. Extensive mining began in 1740, when the Portuguese Government gave the first lease. From 1750 to 1770 was the period of largest production, which tradition places at 150,000 carats a year. During the previous decade it had averaged one-third of that amount. In 1771 the Government took charge of the mining, and some definite records were kept, which showed an annual output of about 40,000 carats. But a great deal of surreptitious mining was done by individuals, of which, of course, no records were made. This condition lasted until about the end of the century, by which time the Government production had fallen to 20,000 carats, while the contraband production is estimated to have been fully as large. With the political changes and uncertainties of

the Napoleonic period, the Government mining was less carefully attended to and gradually gave place to private workings. Since then the production has varied much. The freedom of mining has tended to increase it, but the better-known and more accessible localities have been gradually worked out and improved methods have not been introduced. Sir Richard Burton, who visited Diamantina in 1867, reported a prosperous condition and an annual output of 80,000 carats. The present production is estimated at about one-third that amount.

Within the last thirty years an important diamond-cutting industry has grown up in Diamantina and the adjacent villages. The little mills are worked by water power; the process of cutting is the same as that in Europe. The machinery comes from Holland, and the work is both well and cheaply done. Most of the stones are cut as brilliants. The manufacture of gold jewelry has also developed. The workmen are principally Portuguese, and are skillful and industrious. The designs are old-fashioned, and filagree work is popular. This jewelry is peddled about through the country and finds a ready sale.

Dr. Eugene Hussak, of the School of Mines, Saõ Paulo, Brazil, has published[1] an admirable article entering fully into a description of the so-called favas found in the Brazilian diamond sands. This is a valuable contribution to the literature on the occurrence of diamonds in Brazil.

These favas (the name meaning bean or pea) are circular or flat, rounded and waterworn concretions or pebbles, measuring two-fifths of an inch in width and from one-fifth to two-fifths of an inch in length. They are yellow, leather brown, tile red, dark gray, or blue gray in color, compact in structure, and of high specific gravity. They are found everywhere in the washing of the diamond sands (cascalhos), together with the accompanying minerals of the diamond Leitminerale (boa formação). They were first described by Damour,[2] and are classified as follows: (1) Siliceous favas, generally yellow-brown jasper or hornstone; (2) a hydrophosphate of alumina, with a specific gravity of 3.14; and (3) those termed by Damour chlorophosphate.

In this investigation Dr. Hussak enters into an exhaustive description of forms, appearances, and associations of all the minerals, with many references to the literature on the subject. Dr. Hussak has also carefully sorted the minerals from nine great mining districts, viz, Rio Paraguassú (Bandeira do Mello), San Isabel do Paraguassú, Mte. Veneno, Andarahy, Lençoes, Pitanga, Salobro, and Sincora, and has separated and given a description of the 39 associated minerals, as follows: Quartz, sandstone (siliceous slate) and jasper, orthoclase, biotite, muscovite, chlorite, talc, amphibole, epidote, garnet, sapphire and ruby, monazite, xenotime, ceylonite, fibroceylonite, fibrolite, disthene,

[1] Tschermaks mineral. und petrog. Mittheil., Vol. XVIII, No. 4, 1899, pp. 334-359.

[2] Bull. Soc. géol. France, 2d series, Vol. XIII, 1855-56.

diaspore, rutile, anatase, brookite, cassiterite, columbite, zircon, chrysoberyl, euclase, titanite, tourmaline, staurolite, lazulite, ilmenite, magnetite, pyrite, limonite, psilomelane, marcasite, cinnabar, and gold.

He finds that the blue-gray titaniferous favas contain, according to analysis by Mr. W. Florence, the following constituents, showing them to be arkansite or anatase in pebble form:

Analysis of blue-gray titaniferous favas from Brazil.

Constituent.	Per cent.
TiO_2	98.98
Al_2O_3	.15
Fe_2O_3	.10
CaO	.15
Water, by ignition	.77
Total	100.15

These favas have a specific gravity of 3.794, a hardness very near that of quartz, and are generally in octohedral forms, but frequently in rolled pebbles.

A fava from Rio Cipo gave a specific gravity of 3.95 and a hardness of 6.

Analysis of favas from Rio Cipo, Brazil.

[W. Florence, analyst.]

Constituent.	Per cent.
TiO_2	98.86
V_2O_5	.86
Water, by ignition	.53
Total	100.25

PRICE OF THE DIAMOND.

The syndicate which purchased the diamond output felt that the coming prosperity and increased demand warranted them in advancing the price of the gems. Commencing with May last they made several advances of 5 per cent, until, in December of the present year (1899), the price of cut diamonds had increased 30 per cent. This advance was not due to any stringency or lack of supply caused by the Transvaal war, to which many attribute it. The increase in price caused great trouble among the diamond-cutting firms, both abroad and in the United States, and in February, 1900, it resulted in the shutting

up of many of the workshops. It is said that in Amsterdam alone 2,500 diamond cutters suspended work, and in the United States about 400. Many owners of old and what may be termed pre-African mine stones—that is, old Brazilian stones, which were poorer in cutting, as compared with modern methods, and generally imperfect—learning of an advance in the price of diamonds, thought this an excellent opportunity for them to dispose of their gems; but, not realizing that diamonds are always sold on a gold basis, and that many of their stones were bought when gold was at a premium of 2.70 and at a time when diamonds of more than 2 carats were extremely rare, their attempts to dispose of them were naturally disappointing.

SOURCE AND ORIGIN OF THE DIAMOND.

The much-debated question of the source and origin of the African diamonds has been approached afresh, in the light of recent observations, by Mr. T. G. Bonney, in a lecture before the Royal Society of London, June 1, 1899. After describing the structure of the Kimberley pipes and the associated minerals found in the blue ground, Mr. Bonney reviewed the theories as to their origin thus far held. The late Prof. H. Carvill Lewis regarded the rock as a porphyritic peridotite more or less serpentined, sometimes passing into a tuff or breccia, and the diamonds are derived by the action of this heated material in traversing the carbonaceous Karoo shales.[1] Others have regarded it as a clastic rock, a volcanic breccia in fact, formed by deep explosions of steam and heated waters, causing uprushes that broke through the sedimentary beds and filled the pipes thus made with débris from the rocks traversed and with fragments of crystalline floor rocks. This view was held by Mr. Bonney,[2] and a somewhat similar one by Dr. William Crookes.[3] The progress of investigation, according to Mr. Bonney, had lately reached a stage where the view that the diamonds were derived from below, rather than formed in situ, had gained many supporters; no evidences of the former presence of peridotite had been found, and, lastly, diamonds had been discovered in so close relation with the pyrope garnets that a common source was indicated. At a depth of 300 feet in the Newlands mine, in Griqualand West, the director, Mr. Trudenbach, had found a specimen of pyrope partly embedded in blue ground and inclosing a small diamond, with others closely adjacent. Appreciating the importance of this discovery, he made further examination and collected a number of rounded bowlders, some of them a foot in diameter, which occur in the blue ground to a depth of 300 feet. These were largely of eclogite, pyrope and chrome

[1] Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), pp. 1191-1195.
[2] Nineteenth Ann. Rept. U. S. Geol. Survey, Part VI (Continued), pp. 500-501.
[3] Ibid. p. 502.

diopside, and on being broken some were found to contain small diamonds.

Mr. Bonney describes these remarkable specimens, several of which have been examined by himself and Dr. Crookes, and draws from them the following important conclusions: (1) The diamond here occurs in truly waterworn bowlders of eclogite, which rock is at least one original matrix of diamond; (2) the diamonds are derivative minerals and not formed in the blue ground; (3) the blue ground is not an altered peridotite, but a volcanic breccia, as maintained by Bonney and Crookes. The extreme alterations in both the mass and the included fragments are explained by the long-continued action of steam and heated water ascending through the pipes, which had been filled with mingled débris of all the rocks down to the seat of the outbreak.

It may be observed, in addition, that the bowlders found here, and also noted by Stelzner [1] at Kimberley, indicate a land surface traversed by rivers and composed of these rocks (eclogite and diabase), at least in part, now buried beneath the entire depth of the Triassic Karoo shales, thus showing a great depression of this whole region from its Paleozoic level. The age of the crystalline rocks themselves is, of course, unknown, though it is clearly very remote. These geologic aspects are of great interest, although Mr. Bonney's lecture deals mainly with the problem relating to diamond genesis, so largely discussed by himself and others.

CORUNDUM GEMS.

NORTH CAROLINA.

The ruby corundum of the Cowee Valley of North Carolina, first noted by the writer,[2] has recently been described quite fully in an article "On a new mode of occurrence of ruby in North Carolina," by Prof. J. W. Judd and Mr. W. E. Hidden.[3] Professor Judd, it will be remembered, was associated with Mr. C. Barrington Brown in the celebrated report upon the ruby mines of Burma, reviewed in this report for 1895.[4] In that article he gives some of the conclusions arrived at by Mr. Brown during his visit to the Cowee Valley district in 1896, mentioned in the report of this bureau for that year[5] as likely to yield interesting results.

The first reports stated that the corundum crystals were found in the débris of a calcareous rock underneath the surface deposits of the

[1] Sitzungsb. und Abhandl. der Gesell. Isis., Dresden, 1893. p. 71.

[2] Mineral Resources of the United States, 1893, p. 693; Sixteenth Ann. Rept. U. S. Geol. Survey, Part IV, p. 599; Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), p. 905; Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), p. 1197.

[3] Am. Jour. Sci., Vol. VIII, 4th series, No. 47, November, 1899, p. 370.

[4] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), pp. 905-906.

[5] Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), p. 1197.

Cowee Valley, and had even been traced to a limestone matrix adjoining. The resemblance to the Burman occurrence was apparently striking, and the examination by Mr. Brown was awaited with interest. It now appears that the first accounts were not strictly correct, and that the crystals are not derived from a limestone at all, but from certain highly altered basic silicate rocks, probably of igneous origin. The country rock is gneissic, often carrying garnet and corundum, but the latter is in elongated prismatic forms and not of gem quality. These gneisses are also traversed by dikes of pegmatite. Garnet is mined as an abrasive in some of gneissic rocks, and mica is mined in the pegmatite. None of the dunite rocks or derived serpentines which we associated with the noted corundum localities at Buck Creek, Ellijay, etc., are found in the Cowee district, though the distance between them is not great; and no limestones occur within 8 or 10 miles of the ruby-bearing alluvium.

The surface deposits are underlain by several feet of gravel, beneath which is a soft, decomposed rock termed saprolite, resulting from the decay, in place, of basic silicates. The unaltered rock is found below, sometimes at considerable depths. The saprolite, washed and microscopically examined, is found to consist largely of scales of hydrous micas, through which are distributed the less-changed or unchanged minerals—fibrolite, staurolite, etc.—with rutile, menaccanite, monazite, and spinel, much garnet (including the brilliant gem variety rhodolite, to which reference is made elsewhere), corundum, and a little gold and sperrylite.

At a depth of 35 feet this material begins to show fragments of basic rocks, and at lower depths gradually passes into them. These basic rocks include hornblende-eclogite (garnet-amphibolite of some authors), amphibolite, and a basic hornblende-gneiss containing labradorite and perhaps anorthite. A full description of these rocks is deferred until further explorations have been completed and material obtained more free from alterations. Professor Judd states that "it is as yet uncertain whether these rocks occur as dikes or as alternating interfoliated masses in the crystalline series."

The extreme decomposition of these basic rocks into the saprolite condition is thought to be connected with a very marked system of faults and slickensides by which they are traversed, and which must have afforded easy access to water, with consequent alteration. The saprolite contains much eclogite and amphibolite, sometimes in large pieces, which have escaped disintegration, and these usually have nuclei of pure hornblende. Corundum is especially abundant adjacent to these hornblende lenticles, sometimes pure and often in altered pseudomorphs.

The corundum itself varies from white or colorless, through various shades of pink, to a true ruby tint, resembling the color of fine Burman

gems, and to other varieties of red. In nearly all instances the crystals have inclusions—the cloudy "silk" of microscopic fibers, minute rutile and menaccanite, and sometimes well-developed garnets; but many small ones are of clear gem quality. The best crystals show the tabular form which Lagorio regards as belonging to corundum that has crystallized from an igneous magma. So general, indeed, is this form that any long prismatic crystal found with the others is suspected of being derived from the adjacent gneiss rock, in which this is the prevailing type. The crystals occur either in the midst of the rock, or grouped in bands or nests, or in what appear to have been cavities, alike in the eclogite, the amphibolite, or the hornblende-gneiss. "These spaces, when the corundum is pale colored, appear to have been filled up with the feldspathic material; but when the corundum is of a ruby red, the surrounding space is filled up with chloritic material."

Alteration of corundum has taken place very extensively, as in Burma, apparently first by hydration and then by combination of the resulting diaspore with surrounding silicates. "It is surprising to see the positive evidence of the former existence of hundreds of pounds weight of ruby and other corundum, where to-day only a few ounces of fragments or flakes remain." These often exist as the centers of altered masses, which preserve the entire form of the original corundum crystals and are embedded in the rock.

Passing, then, to the associated minerals, by far the most notable is the purplish-pink garnet, designated as rhodolite, which is elsewhere described in this paper and has been referred to in previous reports.[1] It is found chiefly in rolled fragments, with corundum and the associated minerals, in the gravel and the saprolite. The only crystals thus far obtained are very small dodecahedrons and trapezohedrons, occurring as inclusions in the ruby corundum. This feature is peculiar to the Cowee district, being entirely unknown in the corundums of the peridotite (dunite) areas or their contact zones with the schists. There is ample evidence that these garnets crystallized first and the corundum later, more or less inclosing the former. Ruby crystals exhibit the garnets either partly or wholly included, and also often show cavities where the garnets have decomposed—artificial casts reproducing the garnet forms. A striking figure is given of a low prism of corundum with three trapezohedral garnets about half inclosed and half protruding.

Spinel, so frequently an associate in Burma, is rare here, the ruby variety being entirely absent. Among minerals suggestive of contact alteration are sillimanite (fibrolite), cyanite, staurolite, and iolite, the staurolite being sometimes clear and gem-like. The ferromagnesian

---

[1] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), p. 911; Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), p. 1197; Nineteenth Ann. Rept. U. S. Geol. Survey, Part VI (Continued), p. 505.

silicates are chiefly a soda hornblende and a bronzite in transparent masses suitable for gems—an interesting novelty. Other species are zircon, monazite, rutile, and menaccanite, and among metallic species pyrite, chalcopyrite, nickeliferous pyrrhotite, blende, sperrylite, and gold.

In summing up, the paper notes that three distinct modes of occurrence for corundum are now recognized in North Carolina: (1) In the crystalline schists, as long prismatic crystals, usually gray, pink, or blue; (2) in the peridotites (dunites) that intersect the schists, especially at the contact zones, the crystals, often large and varied in color, but never, or very rarely, of gem quality; and (3) in the garnetiferous basic rocks of the Cowee district as small crystals, low hexagonal or tabular, and partly rhombohedral, frequently transparent and of a fine red color. The second of these modes of occurrence has been described and discussed by Dr. J. H. Pratt in the article elsewhere reviewed in this paper.

Throughout this region there seems to be nothing resembling the mode of occurrence in Ontario—in syenitic dikes associated with nepheline, so fully described in the article of Professor Miller, also reviewed in this paper. This would indicate still a fourth association for corundum, entirely distinct, unless, indeed, the promised further examination of the basic rocks that have yielded the saprolite may develop resemblances.

The forms of the Cowee crystals are quite fully treated in a supplementary paper by Dr. Pratt, and compared with those of the sapphires from Yogo Gulch, Montana, described by him in 1897.[1] It then appeared that the basal and prismatic types among Montana crystals were characteristic of the Missouri bars, while rhombohedral forms were marked in the Yogo Gulch specimens; and this difference was referred to in the paper just cited[2] as peculiar, in view of both types being derived from igneous rocks of the same general region. In the Cowee specimens, however, the two types appear from the same rocks, and no such distinction is recognizable. Some of the crystals are noted as having a very close resemblance to Montana specimens described in Dr. Pratt's former article and others to Burman crystals studied and figured by Dr. Max Bauer.[3] The striations, passing into triangular steps on the basal plane, also observed on Yogo Gulch sapphires, are frequent and conspicuous on the specimens from Cowee.

These forms of corundum crystals are considered by Lagorio, as already mentioned, to be characteristic of those that have separated from an igneous magma. The singular fact that the Cowee crystals were formed subsequent to the garnets which they inclose or envelop

[1] Am. Jour. Sci., 4th series, Vol. IV, p. 424; Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), pp. 1200–1201.

[2] Eighteenth Ann. Rept. U. S. Geol. Survey, Part V (Continued), pp. 1200-1201.

[3] Neues Jahrb. fur Mineral., 1896, Vol. II, p. 197.

is considered in its bearing on this theory, with which it at first seems incompatible, the fusing point of garnet being far below that of corundum. The point is noted, however, that an important distinction has been overlooked. "The temperature at which alumina is dissolved in a mixture of silicates has no necessary connection with the fusing point of alumina itself." The perfect crystals of garnet prove that the rock must have consolidated from a magma in a state of (perhaps aqueo-igneous) fusion at a temperature below the fusing point of the garnets; and at such temperatures Morozewicz has shown that alumina may be dissolved in basic magma and slowly crystallize out. This condition would explain the peculiar relations of these minerals at Cowee.

In closing, Professor Judd alludes to the marked difference between the corundum-bearing rock here and the limestone matrix in Burmah, although much in the association is very similar. He recalls the views suggested by himself, that the Burman limestone may have been produced by the alteration of a lime feldspar,[1] and suggests that the original magma may not have differed very widely in the two cases, although the resulting products are very unlike. He looks to further investigation as promising much light on the manner of formation of corundum when fuller data are gathered in the Cowee region as to the rocks and their associated minerals.

CALIFORNIA.

A very interesting discovery of corundum in Plumas County, California, has been made by Mr. J. A. Edman, in his studies of the great serpentine belt of that district. Plumas County is traversed at various points by large dikes, chiefly of felsites and felsitic porphyries. At a point near the western base of the serpentine, a large felsitic dike, or rather pipe, outcrops on the surface, and in the soil near it were found fragments of a feldspar containing corundum crystals. Further explorations have shown a layer of feldspar 4 feet wide between the dike matter and the serpentine. This feldspar is much altered in the vicinity of the intruded mass, and has since suffered much decomposition, but contains few signs of developed corundum crystals. The feldspathic fragments found in the soil below the dike frequently contain crystals of gray corundum, and single crystals are occasionally obtained by washing the soil.

The largest crystal thus far found is 2 inches long by 1 inch wide, of a bluish-gray color, and with a specific gravity of 3.91. In its interior it shows several blue zones parallel to the faces of the prism. The general habit of the crystals is that of the hexagonal pyramid, tabular forms occasionally occurring.

[1] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), pp. 905–906.

The associated feldspar, which has not yet been fully determined, is probably a mixture of several varieties or species of that mineral with amorphous corundum, a fact which is indicated both by its varying hardness and by the frequently noted condition of the corundum crystals, from which small veins and strings of corundum ramify into the feldspathic mass surrounding them. This is a very peculiar feature and one rarely or never noted elsewhere. The deposit appears to verify remarkably the theoretical deductions drawn from the experiments of Joseph Morozewicz, as described in his late paper.[1]

Some specimens from the outer edge of the feldspar zone indicate that the feldspathic matter, in a plastic condition, has apparently penetrated among the shattered fragments of the serpentine and cemented them into a breccia.

No gems or clear crystals have yet been found, nor, indeed, have they been specially searched for, but Mr. Edman will explore the bed of an adjoining gulch when a supply of water can be had. The soil below the dike will also be carefully washed to determine whether any sapphires are present. The extent of the deposit has not yet been determined.

CANADA.

A full account of the corundum deposits of Canada, which were referred to in this report for 1897,[2] has lately appeared in the Report of the Bureau of Mines of Ontario, Vol. VII, part 3, 1898. It describes in detail the history, explorations, occurrence, and distribution of these apparently extensive and important corundum beds, as examined for the bureau by Mr. Willet G. Miller, the author of the report, and others associated with him as field assistants or in special laboratory tests. Although corundum was reported near Burgess as long ago as 1863,[3] by the late Prof. T. S. Hunt, yet the locality had been almost lost sight of, and the occurrence had attracted little notice. In 1896 Mr. W. F. Ferrier, lithologist, of the Dominion survey, recognized and announced it from Carlow Township, in Hastings County.[4] The appointment of Mr. Miller for a special investigation followed in the next season, and the work here described was done between the months of June and November, 1897. One or two localities were thoroughly examined, the mode of occurrence was determined, and the mineral then traced at several localities through a somewhat extended adjacent region. The occurrence near Burgess was looked up and rediscovered, and other occurrences also were located in that vicinity.

The corundum occurs chiefly in dikes of syenite penetrating a dark-

[1] Experimentelle Untersuchungen über die Bildung der Minerale in Magma: Tschermaks mineral. und petrog. Mittheil., Vol. XVIII, Nos. 2 and 3, pp. 105-240.

[2] Twentieth Ann. Rept. U. S. Geol. Survey, Part VI (Continued), pp. 570-573.

[3] Geology of Canada, 1863, p. 199.

[4] Rept. Bureau of Mines of Ontario, Vol. VI, pp. 61-63.

colored gneissic rock of Laurentian age, which itself is regarded as of igneous character—originally a gabbro or gabbro-diorite. With these syenite dikes are closely associated other dikes of granite which do not carry corundum; and all are traversed by a later series of veins and dikes of pegmatite, also barren of corundum. In this respect the earlier statement referred to in this report[1] must be modified. The only occurrence of corundum, other than in the syenite, is that at the rediscovered locality at North Burgess, where it is found in crystalline limestone, as in Burma and northern New Jersey, in a wholly different association. The form here is that of small crystalline grains of rosy-red and blue colors, which are harder than topaz; but they have not been thoroughly analyzed and may possibly prove to be spinel.

The syenite rock, which alone carries the corundum that has any value, presents some peculiar and interesting features. It contains quite largely the mineral nepheline, and a curious relation, of a somewhat inverse character, exists between the content of nepheline and that of corundum. The rock is mainly feldspathic, in color usually pink, though often gray or white; hornblende is present frequently, also a white and a black mica; but there is absolutely no quartz. The feldspar is more or less replaced by the related mineral nepheline, and corundum is often abundant. In the nepheline-syenite the corundum is less plentiful, sometimes absent, but its crystals are well formed and distinct, while in the feldspathic syenite it is more abundant, but not so well formed.

Mr. Miller describes how he made use of this difference in his explorations. When he encountered nepheline-syenite without corundum, by following the strike he soon found the nephelite diminishing in amount and the corundum coming in. The ordinary syenite and the nepheline-syenite might be taken for rocks of distinct origin, were it not for the fact that they both contain corundum and that they pass into each other, sometimes very gradually, sometimes quite abruptly.

The feldspars contain an average of about 20 per cent of alumina, while nephelite contains about 34 per cent. It would seem, therefore, that in some way the alumina present in the mass in excess of the feldspars has in some cases combined with bases and silica as nephelite and in others remained free as corundum. A very interesting discussion is given upon this point. The presence of corundum in igneous rocks has been attributed by some to their having cut through highly aluminous beds in the course of their extrusion and having thus taken up an excess of alumina, which crystallized out as corundum during the cooling of the mass. In the case of the nepheline-syenites this alumina would unite with silica and bases, if such there were in proper amount, to form nephelite. But Mr. Miller does not regard this condition as necessary. He gives it as but one of three hypotheses to

[1] Nineteenth Ann. Rept. U. S. Geol. Survey, Part VI (Continued), pp. 503-504.

account for the excess of alumina, the others being that the rocks are either (1) re-fused sedimentary matter or (2) derived from an original magma rich in alumina. The gneissoid rocks which the syenite dikes traverse contain about 20 per cent of alumina—an average of three analyses—while ordinary syenites, or those carrying mica, hornblende, or augite, contain from 16 to 17 per cent alumina, and nepheline-syenites about 22 per cent alumina. Mr. Miller goes on to say:

Thus there is a difference between the alumina contents of the nepheline-syenite and other syenites of, on the average, 5 per cent. Since corundum is absent in parts of some of the dikes and masses and is absent or very sparingly present in the whole of other dikes or masses, it may be safe to assume that the proportion of free alumina (corundum) in all of the syenite of all kinds in the district is less than 5 per cent. In considering the origin of the corundum the question then arises, Did that part of the magma from which the syenites * * * originated possess a chemical composition similar to that of nepheline-syenite, and would this magma under the proper conditions have crystallized into a mass composed largely of nepheline-syenite with no free alumina, or was the part of the alumina now existing as corundum originally a constituent of nepheline or other mineral, and was this mineral decomposed, giving rise to less highly aluminous silicates and corundum?

The syenite dikes vary in width from a few inches to large masses covering considerable areas. The granite dikes and masses contain no corundum and were not particularly examined, once this feature was found to be constant. The relations of the two rocks are not yet determined, though Mr. Miller inclines to regard them as belonging to the same period. There is often close resemblance between them, but the presence of quartz in the granite and its absence in the syenite is a constant feature of distinction. The later series of dikes of pegmatite or coarsely crystalline granite also resemble some varieties of the syenite, especially those of coarser texture and pink color.

Nepheline being generally a rare mineral, some curious mistakes are noted on the part of landowners. In one case it was mistaken for limestone, and persistent attempts were made to burn it in kilns, with results more interesting to the mineralogist than to the lime seeker. In some instances the nepheline was fused and the feldspar left as a sort of skeleton of the rock. Sometimes, when not quite fused, the nepheline had assumed a blue color on the surface, resembling the sodalite which is frequently associated with it. Another unprofitable experiment planned, but not carried out, was to ship a quantity of the rock to Detroit as a particularly pure feldspar for porcelain making.

The region characterized by the presence of these syenites is now found to be quite extensive. The rock occurs at a number of points, which fall into three somewhat parallel belts, with a course from a little north of east to south of west, in the counties of Renfrew, Hastings, and Peterboro. These belts or bands are, respectively, distant about 60, 40, and 20 miles NNW. from the Canadian Pacific Railway, on its course between Peterboro and Sharbot Lake. The northern

band is by far the most extensive and important. It has been traced by Mr. Miller and his assistants for a distance of some 30 miles in Renfrew County and the northern part of Hastings County, through the townships of Sebastopol, Brudenell, Lyndoch, Radcliffe, Raglan, Carlow, and Bangor, in all of which corundum occurs. The second band of nepheline-syenite appears at two points—an area in Dungannon and Faraday townships, Hastings County—and a smaller one west of it in Glamorgan Township, Peterboro County, on the edge of Haliburton. At these points, however, no corundum has yet been found. The third belt is represented by a small region in Methuen Township, Peterboro County, where corundum again occurs as in the northern belt. At present the Methuen locality is opened and worked for mica only, the corundum not being abundant. In some cases, however, it is blue and somewhat translucent, making a nearer approach to gem varieties than that from anywhere else in the Ontario region.

The middle belt, as stated, carries no corundum. It has been studied by Dr. F. D. Adams and others on behalf of the Dominion survey, chiefly in its geologic aspects and on account of the remarkable development of the nepheline-syenite. Mr. Miller thinks that probably corundum may occur sparingly at points, but that, not having been particularly sought, it has hitherto escaped notice.

The northern belt is the only one in which corundum occurs in quantities or promises to be commercially important. Here the district is 30 miles in length and varies in width from 3 or 4 miles to 8 or 9 miles, and outcrops have been found over an area of nearly 100 square miles. Much of the report is occupied by a detailed account of these outcrops, and the mode of occurrence of the corundum in each township.

Mr. Miller, in closing this part of his report, treats of several interesting mineral occurrences in the corundum district, and particularly of a locality in Lyndoch Township, where beryl is found, with quartz and amazon-stone, together with some fluorite, and one or two rare minerals, apparently columbite and perhaps samarskite or fergusonite, the former in some abundance and the last of special interest from its connection with helium. These "rare earth" minerals are new to Ontario Province, and Mr. Miller discusses their mode of occurrence and association as compared with localities in the United States.

Two supplementary reports follow, one on analyses of corundum and corundiferous rocks, by Mr. W. L. Goodwin, and one on concentration of corundum, by Mr. Courtenay De Kalb, of the Kingston School of Mining. Mr. Goodwin's report gives results of analyses of Canadian corundum, showing a percentage of alumina varying between 96.26 and 97.27. He then discusses methods of determining the amount of corundum in rock samples, a work which is attended with considerable difficulty. The method employed was based upon the nonsolubility of corundum, especially after ignition, in hydrofluoric acid,

which dissolves the other rock contents. Some results are given, and the investigation is stated to be still in progress.

The second paper is quite elaborate and deals with a variety of tests and processes, being illustrated with tables and diagrams for crushing, separating, and concentrating. Mr. De Kalb concludes, among other results, that the prospect of employing corundum as an ore of aluminum is not very promising. He obtained a product carrying over 99 per cent of corundum. This contained, however, 0.4 per cent of silica and 0.39 per cent of ferric oxide, while selected grains had nearly as much iron, though the silica was reduced to 0.07 per cent. As the aluminum manufacturers require a material that shall not contain more than 0.10 per cent of silica and 0.05 per cent of ferric oxide, it appears that, without some further process of purification, the Canadian product can not compete with the purified bauxite mainly employed, and whether such process would be commercially practicable is doubtful.

INDIA.

An important account of the occurrence of corundum at various localities in the peninsula of India has lately been published by the Indian government as one of the issues of its geological survey.[1] The special treatment of corundum is by Mr. T. H. Holland, deputy superintendent of the survey. After a general introduction regarding the interest that attaches to corundum, especially as a gem stone, and a brief historical account of it, a chapter is given to its mineralogical character, its crystallography, the variations in hardness and density between some of its varieties, its color and optical phenomena, its chemical constitution and alterations, its occurrence with iron in the form of emery, the processes and prospects for its artificial production, etc. The next chapter considers in some detail its geological relations, comparing the Indian occurrences with those of other regions, especially Burma and the United States. Mr. Holland notes the fact that it is only recently that corundum has been found *in situ*, save in a very few localities, but that now enough occurrences of this nature are known to enable us to draw fairly definite conclusions. These seem to show that corundum is properly and frequently an authogenic (or idiomorphic) mineral of igneous rocks—pure alumina separating early from a cooling magma, together with other similar oxides present in excess, in a manner perfectly natural and exactly reproduced artificially by Morozewicz. The frequency of the occurrence of alumina in combinations and the rarity, until recently, of its occurrence pure, have led to the prevailing idea that corundum has been derived from alumi-

[1] A Manual of the Geology of India; Economic Geology, by the late Prof. N. Ball, C. B., LL. D., F. R. S.; Second Edition, Revised in Parts; Part I, Corundum, by T. H. Holland, A. R. C. S., F. G. S., Deputy Superintendent Geological Survey of India. Calcutta, 1898.

nous silicates by contact agency and other forms of local alteration. This view Mr. Holland believes to be true in some cases, perhaps frequently, but it does not countervail the clear evidence for his general argument. As an instance of such processes he notes an occurrence of corundum in the Coimbatore district of Madras, where it is quite abundant in a coarsely crystallized red feldspar forming veins of instrusion in elæolite-syenite. The crystals are evidently authogenic in the feldspar and are similar in form to those obtained by Morozewicz, but they are confined to the portions of the veins adjacent to the elæolite rock, which contains an excess of alumina. Here is plainly seen the influence of contact.[1] The views of Mr. Judd, also on the secondary origin of the Burma rubies, described in this report,[2] are recognized as probably correct. But Mr. Holland regards these cases, and others like them, as of exceptional character.

The principal occurrences of corundum in India are of two kinds—(1) in association with basic rocks; (2) in association with acidic rocks. Both types are well represented. In the former, however. pegmatite intrusions have usually been found in the vicinity.

Corundum associated with basic rocks.—Under the first head the basic rocks carrying corundum are largely composed of pyroxene associated with some one of the spinelloid group, and, according to the character of these minerals, three subdivisions are noted, viz:

(A) Ferruginous; the pyroxene being the highly ferriferous enstatite (or hypersthene) and the spinel either hercynite (FeO, Al_2O_3) or the latter mingled with magnetite (FeO, Fe_2O_3). Ilmenite ($FeTi_2O_3$) may in these cases replace corundum (Al_2O_3).

(B) Ferromagnesian; with the pyroxene a less ferriferous enstatite and the spinelloid, pleonaste ($MgFeO$, Al_2O_3).

(C) Magnesian. Here iron is very sparingly present, and the spinelloid is true ruby spinel (MgO, Al_2O_3).

The isomorphous iron and magnesian protoxides replace one another by insensible gradations, so that the rocks in some places combine or mingle the characters of the above-described groups.

The first and second of these associations (A and B) are described as found thus partly combined in the Mysore State, and are compared with the rocks carrying magnetite and emery in the Cortlandt series of New York and with similar rocks in Saxony. In Mysore the pyroxenic rock forms a hill adjoining an intrusion of olivine-bearing rock (peridotite) partly serpentinized, and consists largely of hypersthene, with fibrolite, and a green spinel containing much minute magnetite. The whole association is closely like that of the emery beds of the Cortlandt series described by the late Prof. G. H. Wil-

[1] These accounts of the occurrence and association of the corundum are very interesting, from their close resemblance to those in the Ontario and California localities described above.

[2] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), p. 906.

liams, in which he noted a similar spinel intermediate between pleonaste and hercynite, while the hercynite of the original locality in the Bohmerwald, whence it was named, has a similar association with corundum. Fibrolite, too, is present at all three of these widely separated points.

The late Dr. F. A. Genth described specimens of a pleonaste-hercynite spinel from India, pseudomorphous after corundum; and Mr. Holland compares these with large, platy crystals of green spinel found by him in the Coimbatore district of Madras, and, with others from the Salem district, having pink corundum cores.

Mr. Holland also refers to the extensive "charnockite series" of southern India—largely pyroxene-bearing granulites in which hypersthene is constantly present. These are associated with the Mysore corundum, and are closely allied to the rocks yielding emery in the Cortlandt series, and also to the pyroxene-granulites of Saxony and the Bohmerwald.

The Burman ruby occurrences are taken as an illustration of the third association (C). Here pyroxenic rocks again appear; but the rubies themselves were traced by Mr. C. Barrington Brown and Prof. John W. Judd[1] to crystalline limestones intercalated with gneisses. These limestones are at times dolomitic (magnesian), and the associated spinel is the magnesia-alumina variety, ruby spinel. Stress is laid on the fact that these limestones are connected with pegmatite, which is "a constant feature also in the Madras corundum deposits," and with pyroxene-granulites similar to the charnockite series in Madras, and marked by a species very near to hypersthene. Just what is the manner of association of these pegmatites and granulites with the limestone beds is not stated. Professor Judd's views are cited with acceptance as to the origin of the limestones from scapolites, formed by "werneritization" from basic plagioclase feldspars, as being derived from originally igneous rocks. It is to be noted, however, that the corundum in these extremely altered rocks is, on Professor Judd's theory, a highly secondary product; while Mr. Holland proceeds to compare the Burman occurrence with that of the Salem district of Madras—the first noted discovery of the mineral *in situ*, which furnished the material used by Count Bournon in his celebrated memoir. It is here found in a gneiss largely composed of anorthite (indianite), and the mode of occurrence and associated minerals have lately been minutely studied by Lacroix, who also finds similar associations in a rock from Ceylon, where limestones and pyroxenic rocks again appear and where precious corundum is frequent. "Ceylon," remarks Mr. Holland, "is geologically a continuation of the Madras Presidency."

Graphite appears freely in the Burman limestones, and has been regarded as proof of their organic origin, as against Professor Judd's

[1] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), p. 905.

theory. Mr. Holland, however, reports finding it in pyroxene granulite and even in elæolite-syenite, at localities in Madras.

The remarkable purple corundum of South Rewah is placed provisionally among the basic occurrences, though the relations of the rocks are not yet fully understood. It is associated with chrome-spinel and a chromiferous mica, together with several other minerals, notably euphyllite.

Corundum associated with acidic rocks.—The most important occurrence of corundum in association with acidic rocks is that of the Kashmir sapphires, which are found in granite. The country rock is a schistose gneiss, with white feldspar, black mica, and garnets, and at one point interstratified with siliceous limestone and anthophyllite (kupfferite). Coarse pegmatite traverses the schists in veins, carrying tourmaline, euclase, kyanite, sapphire, and various other minerals.

Another marked occurrence is that of a vein or bed of blue corundum, with kyanite and damourite, in a coarse-grained quartz rock full of tourmaline and traversed by pegmatite veins, at Balarampur, Manbhum district, Bengal. This mica-corundum vein lies at the junction between a body of metamorphic and "transition" rocks. The corundum crystals, which vary greatly in size and have usually a zoned or banded structure of blue and white, lie inclosed in large, irregular crystals of light-blue kyanite, from which they are often separated by a thin layer of damourite. This latter at times passes insensibly into the surrounding kyanite, showing an origin by alteration therefrom; but the corundum crystals are sharp and distinct, and give no suggestion of being cores or residual portions of larger masses that have altered into kyanite, as Dr. Genth held in many cases. Mr. Holland compares Dr. Genth's account of blue corundum with kyanite, mica, and andalusite from Patrick County, Virginia; and though the associated minerals and rocks are closely similar, he can find not only no indication of the origin of the Bengal kyanite from the corundum, but much evidence against it. He regards the sharp, clear corundum crystals as idiomorphic, and the kyanite as formed around them and afterwards partly altered to the damourite, the excess of simple base separating first, the remainder afterwards uniting with silica.

A further occurrence in association with acidic rocks is that in a group of localities in the Salem district of Madras termed the Paparapatti area. Here the corundum is scattered through large lenticular masses of orthoclase occurring in lines parallel to the strike (NE.–SW.) of gneissic portions of the charnockite series, traversed by veins of granite (pegmatite). The relations of these rocks have not been fully worked out, as Mr. Holland says, and, indeed, there appear to be some discrepancies between the accounts of them given in the chapter already referred to and in the one following. In the lenticles

of red to flesh-colored orthoclase are found, besides the corundum, sillimanite (fibrolite), rutile, green and black spinels, and biotite, which last is markedly peripheral. Minute corundums occur throughout, as well as the large crystals; but it is interesting to note that around the latter the former have disappeared and the feldspar is pure, so that every large crystal is surrounded by a shell or "court" of pink, sometimes white, orthoclase, free from corundum inclusions, from one-eighth to one-fourth of an inch in thickness, which remains when the crystal is broken out. The same or a similar process has occurred at other localities also; thus in the Sithampundi area, in the Salem district, referred to above as the anorthite (indianite) occurrence, the pale-colored corundum crystals and irregularly shaped pieces scattered through the anorthite-gneiss are usually enveloped in a calcite shell of about the same thickness. This would seem to be derived, as Professor Judd thinks the Burman limestones have been, by alteration from anorthite, for the reason that adjacent to them in other portions of the rock are found small red corundums with a shell of anorthite partly changed into calcite.

The whole chapter, while a very interesting and important contribution to our knowledge, gives the impression that more detailed examination is needed, and extensive correlation of the varied modes of occurrence of corundum now known, ere a full understanding can be reached as to the development of this remarkable mineral. Very rapid progress has been made in this direction within recent years, with the general result of proving its authogenic origin in igneous rocks of various kinds. As to its origin by processes of alteration, as held by Professor Judd for that of Burma, the facts just alluded to in the Sithampundi area in Madras may indicate a different aspect, though Mr. Holland does not refer to this. The Canadian occurrences present, or at least suggest, close relationships with those of Coimbatore, and perhaps with those of Paparapatti.

The next chapter of the paper, which is much the longest, is on the geographic distribution of corundum in both the Indian peninsulas, Ceylon not being included in this report, which is chiefly confined to Burma, Madras, and Mysore, the other localities, in many parts of India, being either little worked or, as in some cases, little known. It is impossible in a brief review like this to attempt any analysis of the chapter; the main points have been already noted in these reports,[1] also in the Burma report of Messrs. Brown and Judd. All that is known of the distribution of corundum in India is given, and the account is by far the most complete that has ever appeared.

Chapter V of the paper is on "the uses of corundum and its precious varieties." So far as concerns the possible employment of corundum as an ore of aluminum, Mr. Holland thinks that its value

[1] Seventeenth Ann. Rept. U. S. Geol. Survey, Part III (Continued), p. 905

as an abrasive will prevent such use, at least until the present supply of softer hydrated oxides shall fail. This subject has been referred to, however, in recent reports of this bureau, in connection with the Canadian corundum on the one hand and the rapidly growing manufacture of the new carbide abrasives on the other.

The subject of "effective hardness" is next considered, and the difference between mineralogical hardness and abrasive power noted. In the case of corundum, sapphire is the hardest form, breaking with a sharp, conchoidal fracture, while ruby crystals, and still more the ordinary forms, cleave readily along what are not really cleavage planes, but parting planes upon which softer secondary products have developed. Both the manner of breakage and the admixture, even in small quantities, of these decomposed products tend to lower the abrasive power. Emery, which contains a large proportion of magnetite, is nevertheless often superior to crushed corundum, a fact long ago noted by Mr. T. Dunkin Paret in the manufacture of emery wheels at Stroudsburg, Pennsylvania, from the fact that its corundum is of the sapphire variety, either in minute crystals or sharp fragments; so that unless the magnetite be in too great proportion its effective hardness is higher. The process of determining this hardness by Prof. J. Lawrence Smith's method is there described in detail, but a later and fuller discussion of this whole subject has been given by Prof. W. H. Emerson, an abstract of which appears elsewhere in the present report.

The preparation of emery for the market, its use in various applications, etc., are next described, and some interesting accounts are given of native Indian lapidary work. Besides the "begri," or ordinary lapidary, there are special borers or drillers (bidhiya), who perforate hard gems with a steel gimlet rotated with a bow and a leather strap, using corundum dust with a drip of water. Other processes of like character are described. It is interesting to learn that the ancient method of engraving seals, etc., with corundum is even yet in use in Lucknow and Kashmir; but the process is probably somewhat different. Corundum dust and oil are used, and the instrument is a steel spindle tipped with a small copper disk and revolved against the face of the stone.

Emery wheels, their varieties and uses, are quite fully described; also their economy of time and labor as compared with grindstones, which they are fast replacing for many purposes.

The remainder of the fifth chapter is occupied with a discussion of corundum as a gem. References are made to the folk lore of gem corundum in India, many of which appear in the writings of its classical authors, as to the power belonging to rubies and sapphires for good or ill fortune in all sorts of relations. Both these gems are divided by Hindoo authorities into four castes or grades—Brahman, Kshatriya,

Vaishya, and Shudra, in descending order—according to their quality. The native cutting, still practiced, although considerably diminished by the superior methods of European work, is described on the authority of Mr. W. Hoey, who made a report some years since upon the industries of northern India. Three principal styles are employed: taura, flat on both sides, with beveled edges; mathaila, flat below and convex above (our cabochon), and tilakridar, flat below and facetted above. Various details are also given as to prices paid native cutters, etc.

The value of cut stones is last treated, and the enormous increase in the value of rubies as they increase in size, when of fine quality, and the slight increase in the value of sapphires as they increase in size, are shown. Rubies of more than 4 carats are so rare as to have no regular estimable value. The largest ever brought to Europe were two Burman rubies, imported in 1875, weighing, respectively, 37 and 47 carats, reduced by cutting to $32\frac{5}{16}$ and $38\frac{9}{16}$, and said to have been sold for £10,000 and £20,000, respectively; but it is not known who the purchasers were. Many of the finest rubies are pierced—an evidence of Indian origin. Of these the most noted is that now in the crown of Victoria, Empress of India. It is said to have been given to Edward, the Black Prince, in 1367, by Don Pedro, King of Castile, and to have been worn by Henry V. in his helmet, at Agincourt. This, however, is believed to be a spinel.

The sixth chapter consists of an index to the literature on Indian corundum, both general and classified by provinces. This is followed by an extended glossary of native terms used in connection with the various kinds of corundum, their uses, methods of cutting, etc. The report concludes with a detailed index of localities.

ABRASIVE EFFICIENCY OF CORUNDUM.

An extended paper on this subject was read before the American Institute of Mining Engineers at its meeting in February, 1899, by Prof. W. H. Emerson, of the Georgia School of Technology, Atlanta, Georgia, and published in the transactions of that society. The paper is divided into two parts: (1) The relation between the effective hardness of corundum and its content of water; (2) Smith's test as a means of determining the abrasive efficiency of corundum. The opinion has generally prevailed among students of the subject, several of whom are cited, that the differences in hardness noted among specimens of corundum have some relation to the amount of water present in the mineral, and that a large proportion of water—any amount much above 1 per cent—lowers the effective hardness.

An elaborate investigation undertaken by Professor Emerson to determine this point is described in detail in the first part of the

paper. The methods employed for determining the amount of water in a number of samples, and for its complete separation and the tests for hardness before and after, are minutely described. The results are curiously negative, and show that no fixed relation can be traced between the effective hardness and the percentage of water, though Professor Emerson believes it probable that a very large water content—over 2 per cent—would impair the effective hardness.

The remainder of the paper is given to a very exhaustive series of experiments as to the validity of the usual tests for the abrasive efficiency of corundum. The method almost exclusively pursued, known as Smith's test,[1] consists in grinding a weighed amount of corundum to an impalpable powder on a weighed glass plate, and determining the abrasive efficiency by the loss of weight of the plate. The validity of this process has been questioned in its application to emery and corundum wheels, where the abrading material is fixed and not loose; and Professor Emerson instituted these experiments to obtain some definite results. The apparatus which he devised for this purpose is minutely described, as are also various methods for preparing test pieces of corundum fixed in a cement. The substance to be abraded was a steel plate, and the most satisfactory cement was found to be water glass, with a strong solution of mixed chlorides of calcium, magnesium, and iron, the proportions being given in detail. A large number of tests were then made, for longer and shorter periods, and with all manner of precautions. The results were somewhat inconclusive, with irregularities and exceptions not easily explained. It was shown, however, that there is little or no relation between the abrasive efficiency of corundums and their composition, or their water content, and that the Smith process is not applicable to corundum in a fixed state, however valuable it may be when the mineral is used in a powder.

SAPPHIRES IN MONTANA.

For some years[2] sapphires have been found in the float material on Rock Creek, Granite County, Montana, 35 miles northeast of Phillipsburg, at the base of high mountain placers which were being prospected for gold. In the first material found the prevalent color was the usual Montana green, interspersed with a number of stones of fancy colors. This suggested the idea that if the source could be traced, beds of separate colors might possibly be found. A search was decided upon, and Mr. D. Jankower, who made the exploration, concluded that the source could not be many miles away, because of the high hills surrounding the placers where the float prevailed. He

[1] Described by Prof. J. Lawrence Smith in the American Journal of Science and Arts, November 1850.

[2] See previous issues of Mineral Resources of the United States.

also found whence the ordinary waterworn float material is obtained. From the fact that the matrix still partly adheres to most of the stones found high up the creek, it is evident that the original source is but a short distance away. It is proposed to explore farther in that direction during the coming season.

The prevailing forms of sapphire are tabular hexagonal prisms and small elongated hexagonal prisms with pitted surface, which are remarkable for small colored spots, which, when properly cut, change the entire stone to yellow or brown. The red stones found are pale but pronounced rubies, many of them intensely brilliant; the yellows, many tints of brown, blue-greens, reds, and other colors, are distinct from those found at any other locality, and all of the colors are rendered more brilliant by artificial light.

EMERALD.

As was predicted in our last report, there was an advance in the price of emeralds and pearls during 1899. The demand for emeralds was so great that the United States consul at Bogota, Colombia, Mr. McNally, states that at least seventy-five foreign dealers visited that city at one time; that all business in regard to emeralds came to a standstill; that owners of the shops exposed their wares in the street, accepting bid after bid from the vender until a sale was made, at prices frequently ranging over a hundred per cent beyond those ever paid before; and as the principal mines were virtually at a standstill, there is apparently an absolute dearth of emeralds in Colombia, as those of every quality, even to the very poorest, were purchased.

The excitement has also led to illegitimate attempts to obtain emeralds in various ways, and it is reported that church treasures, statues of saints, etc., have been robbed of emeralds with which they were set. In the vicinity of the Muzo mine some of the natives have turned their chickens loose around the workings, with the intention of killing them in due time, in the hope of finding small emeralds in their crops; and other surreptitious devices have been employed for the same end.

The demand for and scarcity of emeralds has resulted in a search for them in every part of the world, including exploration and opening of the old mines at Habachthal, in the Tyrol; the opening of the mine at Takawaja, in the Ural Mountains, and of the Egyptian mines mentioned in the last report, as well as further search at the Emmaville mines, New South Wales.

The high price of emeralds and the advance of more than 100 per cent caused many to dispose of old stones of fine color, great purity, and large size, so that, although emeralds have never commanded so great a price as during the year 1899, there never has been a time when it was possible to obtain finer stones.

NORTH CAROLINA.

Dr. George P. Merrill describes the emerald mine situated on Brush Creek Mountain, at Enstatoe, Grassy Creek Township, Mitchell County.[1] The country rock is a very evenly banded micaceous gneiss and mica-(biotite-)schist, dipping easterly at a high angle. The vein, so far as could be observed, is about 10 feet in width, and is less sharply differentiated from the country rock than are the veins in the mica mines near Bakersville. The vein material is quartz and feldspar (albite), with irregularly disseminated black tourmalines, black mica, garnets, titanic iron, and beryls. A large majority of the beryls are of the common opaque type, and of a yellowish color, the green varieties (emeralds) occurring very sporadically, sometimes in mica rock, sometimes in the vein. Dr. Merrill agrees with Dr. J. H. Pratt[2] in regarding them as occurring for the most part along or near the contact of the vein and country rock. The crystals are of good color, but mostly small, those clear enough for facetted stones being, so far as observed, rarely over 3 or 4 mm. in diameter.

The extent of the vein is somewhat limited, being cut off by an intrusion of a fine-grained mica-granite. It is evident that this vein is quite distinct from the ordinary mica-(muscovite-)bearing veins of the county. It is not merely quite bare of muscovite, but differs also in the character of its other accessory minerals, and apparently cuts across the country rock at a low angle, instead of running parallel thereto, as do the mica veins.

BERYL AND AQUAMARINE.

In North Carolina aquamarine mines are situated on the Wiseman property near Spruce Pine.[3] These veins, like the mica veins, run with the gneiss, and carry also muscovite, though not enough to be of economic importance. The beryls are of a fine aquamarine tint, and some weighing 20 carats have been found. Honey-yellow beryls are common, fragments sufficiently clear for cutting having been found, but they are not abundant. As a source of aquamarine this locality is very promising.

The Wilson mine at Merryall, Connecticut, has been considerably enlarged during the last year, and some excellent crystals of beryl and golden beryl have been reported by Prof. W. H. Hobbs. Some very fine garnets also appear in the same pegmatite vein.

The old beryl locality at Grafton, New Hampshire, was partly devel-

---

[1] Note on the Gem Mines of Mitchell County, North Carolina; read before the Geological Society of Washington, January, 1899.

[2] Jour. Elisha Mitchell Sci. Soc., Vol. XIV, pt. 2, 1897, p. 80.

[3] Note on the Gem Mines of Mitchell County, North Carolina, by Dr. George P. Merrill.

oped in the summer of 1899. As there were indications of mica, beryl, and garnet, it was decided to develop the locality further in the summer of 1900.

TOURMALINE.

The article by Messrs. Penfield and Foote, describing their investigations and conclusions as to the theoretical constitution of the tourmalines, has been followed by one upon the same subject by Prof. F. W. Clarke, of the United States Geological Survey.[1] In this paper the results of Messrs. Penfield and Foote are in part accepted, and are correlated with previous determinations by Professor Clarke, which have lately been revised and restated. The former have considered all tourmalines as derived from an alumino-boro-silicic acid ($H_{11}Al_3B_2Si_4O_{21}$) with a valency of 9, two of the hydrogens being united to the boron as hydroxyls. Professor Clarke reaches a similar result, but gives the acid the formula—$H_{14}Al_5B_3Si_6O_{31}$. These expressions he reduces to a common basis of 6 atoms of silicon; and then, replacing the aluminum by hydrogen, to show the ultimate acids, they become as follows:

Penfield and Foote,	$H_{30}B_3Si_6O_{31\frac{1}{2}}$
Clarke,	$H_{29}B_3Si_6O_{31}$

This is an approximation so close as to fall within the probable uncertainties of analysis. He presents a series of very careful analyses, computed from the article of Riggs, that lie actually between these limits of variation.

There are excellent analyses, however, which fail to conform altogether to this scheme, beyond any probable allowance for either errors or impurities. The formula proposed, therefore, he feels can hardly be deemed final without further qualification.

Professor Clarke states the conditions requisite for a satisfactory constitutional formula as follows: It must (1) adequately express the constitution of the body, including all variations; (2) it must be applicable to the full discussion of analyses and the distinct separation and expression of commingled isomorphous salts; and (3) it must indicate the relations of the species to allied minerals and those into which it is liable to alter. This third condition is equally important with the others.

Along this line the article proceeds to consider the close relation seen to exist between the tourmalines and the micas, both in association and in alteration, as well as in the mingling of isomorphous molecules. Thus, we find a lithia group, composed of both micas and tourmalines, a muscovite-biotite group, with iron tourmalines, and a magnesian group of tourmalines with phlogopite, in notable association and parallelism. The general formulas of these mica types are

[1] Am. Jour. Sci., August, 1899, Vol. VIII, pp. 111–121.

well known and generally accepted; and Professor Clarke maintains that the salts of the tourmaline acid are probably correlated to them, and introduces a somewhat detailed discussion, with structural formulas, to expound this view. As a result, he reaches a statement for the tourmaline acid, in linear form, as follows:

$$Al_5(SiO_4)_6(BO_2)_2 \quad . \quad BO_3H_2 \quad . \quad H_{12}.$$

In this form it is applicable to a satisfactory discussion of the numerous analyses, the hydrogens being partly or wholly replaced by metals in various groupings. Intermixtures of such molecules in different proportions are then considered and found to yield results in which theory and analysis very closely agree.

With great skill and ingenuity this method is illustrated in a succession of cases. A certain number of molecules (usually three) being taken as yielding a mixture approximating to a given tourmaline, the result is calculated and placed side by side with one or more of the best analyses of that variety, with very striking agreement. As this process is repeated, in successive instances, the correctness of the theory is forcibly impressed upon the reader.

In the light of these evidences, Professor Clarke then returns to the theoretical grouping of the atoms in the molecules, and gives three structural formulas for the tourmaline types before referred to in connection with the three mica types. "These formulæ," he says, "cover all of the established variations in the composition of tourmaline; they render the various replacements of isomorphous admixtures intelligible, and they indicate the directions into which the species commonly alter."

Some partial exceptions, some peculiar corollaries, and some additional suggestions are noted at the close, but in the main the results appear highly satisfactory, and mark an important advance upon our previous understanding of this remarkable group. Professor Clarke feels, however, that future investigations may possibly modify our views, and prove the tourmalines to be derived from some complex boro-silicic acid yet unknown, as well as some other species, like axinite, danburite, datolite, etc. "A series of boro-silicic acids is theoretically conceivable, and until this question has been considered, the constitution of all the minerals above mentioned must be regarded as unsettled."

At Pala, California, Mr. Charles Russell Orcutt has found white tourmaline (achroite), red tourmaline (rubellite) in lepidolite, blue tourmaline (indicolite), and green tourmaline (Brazilian emerald) in crystals of but slight gem value.

ROCK CRYSTAL.

Rock crystal in large transparent masses was found by Mr. W. D. Wood in the vicinity of Bay City, Oregon.

Rock crystal, in simple crystals and in groups and geodes, fairly abundant at various gold mines at Granite Basin, often of some size and beauty, is reported by Mr. J. A. Edman, Plumas County, California.

AMETHYST.

Mr. T. A. Heistand notes the occurrence of amethyst in fine specimens at Cripple Creek, Colorado.

Amethyst is reported by Mr. A. C. Bates, from Divide, 25 miles from Butte, Montana. The purple color, though remarkable for brilliancy and richness, is too unevenly distributed in the specimens to furnish cut gems of more than a carat.

A beautiful crystal 2½ by 1¾ inches, of pale color, resembling those from Rabun County, Georgia, was obtained in a coarse granitic rock by Mrs. Cora L. Cole, near Adair, Indian Territory.

Some beautiful specimens of amethyst of a deep rich purple color, similar to those from Maine and from the Ural Mountains, were found in the Yukon district, Alaska, by Mr. Alfred G. Cunningham, and also in the American territory not far distant from Dawson City, Alaska.

Blue quartz of a beautiful tint, and worthy to be called an ornamental stone, is a constant constituent of the crystalline rocks of southeastern Pennsylvania. Good specimens are obtainable along the Pennypack Creek and near Neshaminy, Bucks County, and pebbles of a beautiful blue have also been found in the drift at Gibson Point, on the Schuylkill, by Mr. S. Harbest Hamilton.

OPAL (PRECIOUS).

An interesting form of precious opal, but in grains too small for cutting, was found by Mr. Ira E. Moore, of Hornbeck, Louisiana, consisting of a mass of sandstone containing large seams of grains from 0.5 mm. to 3 mm. across, cemented by precious opal hydrophane, giving the mass the effect of a beautiful piece of opal, although friable and breaking into minute grains of no value. The origin was probably the same as the very interesting pseudomorphs of wood, shells, bones, etc, at White Cliffs, New South Wales, where a fossiliferous sandstone has had all its fossils altered by the infiltration of heated siliceous or volcanic waters.

SEMIOPAL.

A semiopal, white with a blue tint on a jaspery-colored rock, was found by Mr. J. M. McCollum near Safford, Arizona.

Mr. George W. Ostrander mentions the finding of semiopal, banded and mottled brown and gray, in great quantity at Lovelock, Nevada, with dendrites in the fissures, in a continuous vein of some length.

Mr. L. S. Getchell reports the finding of semiopal in small rounded nodules with a white coat of cacholong, at Pony, Madison County, Wisconsin.

Giovanni D'Achiardi, professor of mineralogy, University of Pisa, publishes an exhaustive study on the specific gravity, composition, etc., of the various forms of opal-like minerals found in Tuscany, which he classifies as the common opals, simple opals, white, milky opaque, black, resinous gray, rose gray, and in San Piero in Campo, island of Elba, giving analyses from a large series of experiments as to specific gravity, absorption of water, and other properties.[1]

GOLDEN OPAL.

Under the name of golden opal a ready market has been found for the fireless, reddish, yellow, and brown opal masses that are found with the rich fire opals at Queretaro, Mexico. This material formerly sold for only a few cents. Now it is facetted and sold for several dollars a carat, although the substance does not possess as much hardness as glass, and therefore has very little durability for wear.

CHALCEDONY.

Mr. J. A. Edman, of Meadow Valley, California, reports chalcedony pebbles of various colors on Upper Spanish Creek, above Green Flat, also a profusion of chalcedony of similarly varied colors and semiopal at an old extinct crater in the El Paso Range of Kern County, about 14 miles east of the Freeman post-office. Nearly a half bushel of nodules of a white chalcedony, translucent and almost transparent, with an opaline tint, measuring from ½ to 1 inch across, were found by Mr. Charles Russel Orcutt very near San Diego, California.

AGATE.

A blue chalcedony (saphirine) of some beauty was found by Mr. James E. Todd in the Bad Lands southeast of the Black Hills, near Hot Springs, South Dakota.

Dr. Charles Palache, in the summer of 1899, while on the Harriman

---

[1] Estratto dagli delle Societa Toscana di Scienze Naturali, Pisa, Proc. verb., Vol. XI, pp. 1-25.

Expedition, found abundance of agate (carnelian, chalcedony) beach pebbles weathered out of basalt, on the shores of Popof Island, near the village of Sand Point, Shumagin Group, Alaska.

SILICIFIED WOOD.

Silicified wood occurs in the lowest member of the Newark formation of the Pomperany Valley, Connecticut. One large trunk, owned at South Britain, Connecticut, is clearly agatized, and has been identified by Prof. W. H. Hobbs.

Silicified wood has been found at various points in the older gravel deposits, notably at the Bean Horn (?) hydraulic mines in Plumas County, California, reported by Mr. J. A. Edman.

JASPER (BLOODSTONE, HELIOTROPE).

Green, red, and red and white banded jasper have been found by Mr. J. A. Edman in the slates and schists west of Meadow Valley, Plumas County, California, also green jasper in the serpentine near that place.

TURQUOISE.

Notwithstanding the many statements which have appeared in the press during the last year, to the effect that a syndicate or trust was being formed for the control of all the turquoise properties in the United States, no such consolidation has taken place, and all the mines are still working independently.

Prof. Erwin Hinckley Barbour, of Lincoln, Nebraska, reports the finding of bone turquoise (odontolite), in the form of waterworn pebbles of about the size of hazelnuts, in Brown County, Nebraska.

Another interesting occurrence was a discovery in 1899, in a rather unexpected place, by the F. E. Hyde Expedition, under the guidance of Mr. Geo. R. Pepper, anthropologist, of turquoise in the Mancos Canyon, forming parts of interesting mosaics, or inlays, and carvings, the former consisting of tadpoles of various sizes, made out of a single piece of turquoise from $\frac{1}{4}$ inch to 1 inch in length, many of which were of a rich green color, while others still retained some of the original blue color. These were all perforated below, on a ridge projecting beneath the object, so that they could be attached to a garment or necklace. They well represent the size, type, etc., of aboriginal turquoise carving.

Of probably even greater interest were the frogs, nearly 3 inches in length, made of a rich black jet, neatly carved and polished, the form being somewhat idealized. These had two raised eyes of turquoise inserted, and also a band back of the eyes that extended two-thirds

across the object. This band was made of turquoise, which was cut up broader below than above, so that the eyes could be firmly held without slipping into the groove, which was broad below and narrower above. The turquoise and jet were evidently found in the United States, the former probably in New Mexico, the latter in Texas.

GARNET.

Garnet (almandite) continues to be found in choice crystals at Avondale, Delaware County, Pennsylvania. Some of these crystals would probably cut into beautiful gems. Boothwin, Delaware County, Pennsylvania, also yields some clear stones. These are reported by Mr. S. Harbest Hamilton, who also mentions that essonite was discovered recently with green fluorite at Seventieth street and Chester avenue, Philadelphia. Pyrope has been found during the last year, as heretofore, at Green Creek, Pennsylvania.

RHODONITE.

Massive, light-colored rhodonite was observed in some abundance in a gold-bearing quartz vein at the head of Silver Bay, near Sitka, Baranof Island, Alaska, by Dr. Charles Palache while on the Harriman expedition.

CHRYSOCOLLA.

Beautiful chrysocolla, blue in color, which has been mistaken for turquoise, is mentioned by Mr. Roy Hopping as occurring in some quantity in Kern County, California.

CATLINITE.

Dr. W. M. Beauchamp reports catlinite as abundant in New York State, from Montgomery County to Buffalo, in the form of Indian ornaments, it having been introduced in Indian trade a little before the year 1700.

AMBER.

Prof. S. W. Williston mentions finding a number of specimens of amber from the Mohave Cretaceous of Kansas. The quantity is not great and the color very dark. The largest pieces weigh about 1 ounce each.

PRECIOUS STONES OF JAPAN.

A paper by Mr. Kotora Jimbo, professor of mineralogy in the Science College, Imperial University of Tokio, entitled Notes on the Minerals

of Japan, has appeared recently, having been published in the Journal of the College of Science of that institution, Vol. XI, Part III, 1899. In this extended article of 75 pages Professor Jimbo has brought together a large body of information, hitherto scattered through various Japanese and European publications, regarding the mineralogy of his country, together with much material of his own, based upon examination of some of the best private collections in Japan and those of the Science College of Tokio.

So far as concerns precious stones, however, there is nothing of high importance, though most of the gem-yielding species are found. The clear rock crystal that has furnished the beautiful spheres so much valued and sought for as articles of vertu is limited in amount and largely exhausted. Professor Jimbo states that in Kai Province, although ordinary crystals 6 inches in diameter or even larger are found, transparent ones suitable for crystal balls are no longer procurable. He describes a number of localities for crystallized quartz—colorless, smoky, and amethystine—and gives interesting accounts of parallel growths, etc., whereby two or all three of these varieties are developed together. Such are some crystals from Tanokamiyama, in Ōmi Province, where a smoky crystal will be surrounded by a white or colorless zone, and this again by an overgrowth of small gray or purple crystals oriented parallel to the main one, etc.

The paper is very full in its description of crystallographic phenomena, twinnings, etchings, and the like. Inclosures are treated also, and among them are noted tourmaline, epidote, and native sulphur, as well as fluid cavities, which are at times peculiarly distributed in the quartz crystals.

CHALCEDONY AND AGATE.

Chalcedony and agate are found at various places, and a compact green quartz (prase?) in the provinces of Izumo and Echigo. Curious pseudomorphs of quartz after calcite are described from Osawa, in Shimotsuke Province, and others from a locality in Mino Province, the latter in sharp-pointed rhombohedra. In the Aikawa and Arakawa mines occur numerous peculiar pseudomorphs of quartz after barite, largely in the form of hollow casts from which the barite has been removed. Curious top-shaped chalcedonies from Uzen and Echigo are described as probably pseudomorphous "after broken pieces of some spherical mineral aggregate with radial fibrous structure, and consist of two flat cones united at bases." They are ½ inch in diameter, and the apex of the cones bears either a depression or a rounded elevation.

No mention is made of the rock in which these objects occur, and in the absence of information on that point, the suggestion arises whether they may not possibly prove to be silicified sponges.

CORUNDUM.

Corundum seems to occur very scantily. At Takayama, in Mino Province, small flat hexagonal pieces and columnar grains, blue to bluish-white in color and less than a centimeter in diameter, "were formerly collected." In sections the blue is seen to have concentric zones and radial stripes of white, the zones presenting different figures of uniaxial and biaxial interference.

OPAL.

Opal is mentioned as found at two or three places, but no reference is made to its being beautiful or valuable. Some specimens are noted as showing irregular, doubly refracting bands in thin sections. Hyalite formed in small spherules, either loose or aggregated by waters from hot springs, used to be found at Tateyama, in Etchū. Silicified wood, chiefly coniferous, occurs at many points in the Cretaceous and Tertiary of Hokkaido, and elsewhere.

CHRYSOBERYL.

Chrysoberyl is noted only in a single instance—a small trilling believed to be from Takayama, in Mino Province, in the collection of the Imperial geological survey.

TOPAZ.

Topaz receives considerable attention. There are two main localities—Takayama, in Mino, just mentioned, and Tanokamiyama, Province of Ōmi. The characteristic features of those from the two districts are given in much detail, and may be summarized as follows: The crystals of Mino are often rounded by rolling. They vary widely in size, from 0.2 to 12.5 cm. in the longer basal diameter. In color they are of brownish and bluish tints, also sometimes colorless, occasionally a very rich pale green, and sometimes showing a curious division into sections of different colors—bluish along the macrodiagonal or toward its extremities, and brownish along the brachydiagonal or at its ends. Basal sections show complicated optical anomalies, somewhat different from those in Brazilian topazes described by Braun.[1] In form the crystals are often long prismatic, terminated by domes or by pyramidal or basal planes. Inclosures were noted of tourmaline, cassiterite, and chlorite (?), besides fluid and gas cavities. The Ōmi crystals are less varied in size, rarely less than 1 cm. in diameter. They are usually colorless, though sometimes the bluish and brownish pleochro-

[1] Optischen Anomalien, 1890.

ism is found. In form they are usually short prismatic, generally terminated by domes. The inclosed minerals noted were tourmaline, beryl (?), and monazite. A peculiar relation is observed between the Ōmi topazes and a flesh-red potash feldspar, with apparently two generations of crystals—an earlier one intergrown with the feldspar, and a later one of small, double-terminated crystals formed upon it.

Two analyses of Ōmi topaz, made by Mr. Takayama, chemist to the Imperial geological survey, are of interest because of their low percentage of silica and rather unsual amount of fluorine.

Analyses of topaz from Ōmi, Japan.

Constituent.	I.	II.	Mean.
	Per cent.	*Per cent.*	*Per cent.*
SiO_2	31.30	31.95	31.62
Al_2O_3	56.72	56.59	56.65
F	18.36	18.01	18.18
Total	106.38	106.55	106.45

TOURMALINE.

No gem tourmalines are referred to at all in Professor Jimbo's paper. Black crystals are mentioned as occasionally found in pegmatite at several localities, and some curious, nearly flat, rhombohedral forms, about 2 inches in diameter, with the prism almost wanting, at Goshodaira, in Shinano Province. Radiated aggregations of dark-brown tourmaline occur in a quartz vein in pegmatite at Obira, in Bungo Province, sometimes forming acicular inclusions in the quartz. Of interest in connection with the paper (elsewhere reviewed in this report) on tourmaline and its relation to the micas, by Prof. F. W. Clarke, is the mention of a pseudomorph of mica after tourmaline, as noted at Yokogawa, Province of Hitachi.

GARNET.

A number of varieties and localities are reported, but as no careful analyses have yet been made, Professor Jimbo says that the Japanese garnets can only be provisionally described. From his account it would seem that almost all the species of the garnet group must occur in Japan, but they are not yet identified and can not be definitely named. Various localities are mentioned for yellow and dark garnets, as well as the more common varieties, and their modes of occurrence and crystalline forms are specially noted. A brown-red garnet, in crystals and in sand, from Kongōsan, in Kawachi Province, is largely used in Tokio as a polishing material.

BERYL.

This stone is reported from nearly the same localities as the topaz above referred to, but nothing of actual gem quality is noted. Takayama (Mino) yields some crystals, pale blue to nearly colorless, of 1 cm. in diameter, with smoky quartz in pegmatite. Tanokamiyama (Ōmi) has furnished some crystals of larger size, up to 3 cm. in diameter and four or five times that length, transparent to translucent, of greenish and bluish tints.

The general impression given by Professor Jimbo's account is that of interesting possibilities in the future, when careful exploitation of the beryl and garnet localities shall have been effected; but from the present data it is impossible to predict how far Japan has promise of becoming a gem-producing country.

PRODUCTION.

In the following table is given a statement of the production of precious stones in the United States from 1896 to 1899:

Production of precious stones in the United States from 1896 to 1899.

Stone.	1896.	1897.	1898.	1899.
Diamond	None.	None.	None.	$300
Sapphire	$10,000	$25,000	$55,000	68,000
Ruby	1,000	None.	2,000	3,000
Topaz	200	None.	100	None.
Beryl (aquamarine, etc.)	700	1,500	2,200	4,000
Emerald	None.	25	50	50
Phenacite	None.	None.	None.	None.
Tourmaline	3,000	9,125	4,000	2,000
Peridot	500	500	500	500
Quartz, crystal	7,000	12,000	17,000	12,000
Smoky quartz	2,500	1,000	1,000	None.
Rose quartz	500	None.	100	100
Amethyst	500	200	250	250
Prase	100	None.	None.	None.
Gold quartz	10,000	5,000	5,000	500
Rutilated quartz	500	None.	100	50
Dumortierite in quartz	50	None.	None.	None.
Agate	1,000	1,000	1,000	1,000
Moss agate	1,000	1,000	1,000	1,000
Chrysoprase	600	None.	100	100
Silicified wood (silicified and opalized)	4,000	2,000	2,000	3,000
Opal	200	200	200	None.
Garnet (almandite)	500	7,000	5,000	5,000
Garnet (pyrope)	2,000	2,000	2,000	2,000
Topazolite	100	None.	None.	None.
Amazon stone	1,000	500	500	250
Oligoclase	500	25	10	20
Moonstone	250	None.	None.	None.
Turquoise	40,000	55,000	50,000	72,000
Utahlite (compact variscite)	500	100	100	100
Chlorastrolite	500	500	5,000	3,000
Thomsonite	500	500	1,000	1,000
Prehnite	100	100	100	50
Diopside	200	100	None.	None.
Epidote	250	None.	None.	None.
Pyrite	1,000	1,000	1,000	1,000
Malachite	None.	None.	None.	250
Rutile	100	800	110	200
Anthracite	2,000	1,000	1,000	2,000
Catlinite (pipestone)	3,000	2,000	2,000	2,000
Fossil coral	1,000	500	500	50
Arrow points	1,000	1,000	1,000	1,000
Total	97,850	130,675	160,920	185,770

IMPORTS.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1867 to 1899:

Diamonds and other precious stones imported and entered for consumption in the United States, 1867 to 1899, inclusive.

Year ending—	Diamonds.					Diamonds and other stones not set.	Set in gold or other metal.	Total.
	Glaziers'.	Dust.	Rough or uncut.	Set.	Unset.			
June 30, 1867	$906					$1,317,420	$291	$1,318,617
1868	484					1,060,544	1,465	1,062,493
1869	445	$140				1,997,282	23	1,997,890
1870	9,372	71				1,768,324	1,504	1,779,271
1871	976	17				2,349,482	256	2,350,731
1872	2,386	89,707				2,939,155	2,400	3,033,648
1873		40,424	$176,426			2,917,216	326	3,134,392
1874		68,621	144,629			2,158,172	114	2,371,536
1875		32,518	211,920			3,234,319		3,478,757
1876		20,678	186,404			2,409,516	45	2,616,643
1877		45,264	78,033			2,110,215	1,734	2,235,246
1878		36,409	63,270			2,970,469	1,025	3,071,173
1879		18,889	104,158			3,841,335	538	3,964,920
1880		49,360	129,207			6,690,912	765	6,870,244
1881		51,409	233,596			8,320,315	1,307	8,C06,627
1882		92,853	449,513			8,377,20[illegible]	3,205	8,922,771
1883		82,628	443,996			7,598,176	*g* 2,801	8,126,881
1884	22,208	37,121	367,816			8,712,315		9,139,460
1885	11,526	30,426	371,679			5,628,916		6,042,547
Dec. 31, 1886	8,949	32,316	302,822			7,915,660		8,259,747
1887	9,027	33,498	262,357			10,526,998		10,831,880
1888	10,025	29,127	244,876			10,223,630		10,507,658
1889	8,156	68,746	196,294			11,704,808		11,978,004
1890	147,227	179,154	340,915			*e* 12,429,395		13,105,691
1891	*a* 565,623	125,688	(*c*)			*f* 12,065,277		12,756,588
1892	532,246	144,487				*f* 13,845,118		14,521,851
1893	357,939	74,255				*f* 9,765,311		10,197,505
1894	82,081	53,691				*f* 7,291,342		7,427,214
1895	107,463	135,558				*f* 6,330,834		6,573,855
1896	78,990	65,690		(*d*)	(*d*)	*f* 4,471,311		4,618,991
1897	*b* 29,576	167,118	1,386,726	$330	$2,789,924	1,903,055		6,276,729
1898	8,058	240,665	2,513,800	6,622	5,743,026	1,650,770		10,162,941
1899	2,428	618,354	4,896,324	13,388	8,795,541	2,882,496		17,208,531

a Including also engravers', not set, and jewels to be used in the manufacture of watches, from 1891 to 1894; from 1894 to 1896 miners' diamonds are also included.
b Including also miners' and engravers', not set.
c Included with diamonds and other stones from 1891 to 1896.
d Not specified prior to 1897.
e Includes stones set and not specially provided for since 1890.
f Including rough or uncut diamonds.
g Not specified since 1883.

ABRASIVE MATERIALS.

By Edward W. Parker.

SUMMARY.

The subjects considered under this chapter are buhrstones or millstones, corundum, emery, garnet, grindstones, pulpstone, infusorial earth, tripoli, oilstones and whetstones, and quartz used for abrasive purposes. The production of oilstones and whetstones includes scythestones, rubstones, etc. Carborundum and crushed steel, used as abrasives, being essentially manufactured articles, are not included in the mineral abrasives, but are treated in connection with this chapter.

The production of these various articles in 1898 and 1899 is presented in the following table:

Production of abrasive materials in 1898 and 1899.

Article.	1898.		1899.	
	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*	
Buhrstones		$25,934		$28,115
Corundum and emery	4,964	275,064	4,900	150,600
Garnet	2,967	86,850	2,765	98,325
Grindstones		489,769		675,586
Infusorial earth	2,763	16,691	3,302	25,302
Tripoli				11,730
Oilstones and whetstones		180,486		208,283
Quartz		23,990		39,000

The production of each article is discussed in more detail in the following pages.

BUHRSTONES OR MILLSTONES.

PRODUCTION.

Since the introduction of the roller process for making wheat flour the use of buhrstones for this purpose has practically ceased. Millstones for grinding the coarser cereals, paint ore, fertilizers, cement rock, etc., continue to be used, but this trade is comparatively limited. The material from which the domestic millstones is made is a quartz conglomerate rock occurring along the eastern slope of the Allegheny Mountains. It is quarried in Ulster County, New York, Lancaster County, Pennsylvania, and Montgomery County, Virginia. It was formerly produced in North Carolina, but no quarrying has been reported in that State for several years.

The total value of the millstone product of the United States has not exceeded $30,000 in the last ten years. During the decade from 1880 to 1889, inclusive, the average value of the millstone product was over $130,000 per year. In the decade from 1890 to 1899, inclusive, the average value of the product has been less than $22,000 per year. Sympathizing with the general business revival in 1899, the industry, if such it may be called, gained about 8 per cent over 1898, bringing the value of the product up to $28,115, which, while not large in itself, represents the value of the best year's business since 1889.

The production since 1880 and imports since 1868 are shown in the following tables:

Value of buhrstones produced in the United States from 1880 to 1899.

Year.	Value.	Year.	Value.
1880	$200,000	1890	$23,720
1881	150,000	1891	16,587
1882	200,000	1892	23,417
1883	150,000	1893	16,639
1884	150,000	1894	13,887
1885	100,000	1895	22,542
1886	140,000	1896	22,567
1887	100,000	1897	25,932
1888	81,000	1898	25,934
1889	35,155	1899	28,115

IMPORTS.

The following table gives the value of buhrstones and millstones imported into the United States each year since 1868:

Value of buhrstones and millstones imported into the United States from 1868 to 1899.

Year ending—	Rough.	Made into millstones.	Total.
June 30, 1868	$74,224		$74,224
1869	57,942	$2,419	60,361
1870	58,601	2,297	60,898
1871	35,406	3,698	39,104
1872	69,062	5,967	75,029
1873	60,463	8,115	68,578
1874	36,540	43,170	79,710
1875	48,068	66,991	115,059
1876	37,759	46,328	84,087
1877	60,857	23,068	83,925
1878	87,679	1,928	89,607
1879	101,484	5,088	106,572
1880	120,441	4,631	125,072
1881	100,417	3,495	103,912
1882	103,287	747	104,034
1883	73,413	272	73,685
1884	45,837	263	46,100
1885	35,022	455	35,477
Dec. 31, 1886	29,273	662	29,935
1887	23,816	191	24,007
1888	36,523	705	37,228
1889	40,432	452	40,884
1890	32,892	1,103	33,995
1891	23,997	42	24,039
1892	33,657	529	34,186
1893	29,532	729	30,261
1894			a 18,087
1895			20,316
1896			26,965
1897			22,956
1898			22,974
1899			18,881

a Not separately classified after 1893.

CORUNDUM AND EMERY.

PRODUCTION.

A decrease in the production of corundum in North Carolina and an increase in the output of Chester County, Massachusetts, and of emery in Westchester County, New York, with a general decrease in values, were the principal features of interest in this branch of the abrasive-material industry in 1899, resulting as they did, in an increase of 22 per cent in the product and a decrease of 45 per cent in the value. Corundum production in North Carolina decreased from 539 short tons in 1898 to 500 short tons in 1899; the production in Massachusetts increased about 25 per cent, and that of Westchester County from 1,130 to 1,400 tons. From this it appears that the entire production was limited to the old, well-known localities. Discoveries of emery or corundum deposits have been reported in California, Colorado, and New Mexico, but no output was obtained from them in 1899.

The statistics of the production of emery and corundum since 1881 are presented in the following table:

Annual product of corundum and emery since 1881.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1881	500	$80,000	1891	2,247	$90,230
1882	500	80,000	1892	1,771	181,300
1883	550	100,000	1893	1,713	142,325
1884	600	108,000	1894	1,495	95,936
1885	600	108,000	1895	2,102	106,256
1886	645	116,190	1896	2,120	113,246
1887	600	108,000	1897	2,165	106,574
1888	589	91,620	1898	4,064	275,064
1889	2,245	105,567	1899	4,900	150,600
1890	1,970	89,395			

IMPORTS.

The corundum used in the United States is exclusively of domestic production. Emery is imported from Turkey and the island of Naxos, one of the Cyclades group in the Grecian Archipelago.

The following table shows the imports of emery from 1867 to 1899:

Emery imported into the United States from 1867 to 1899, inclusive.

Year ending—	Grains.		Ore or rock.		Pulverized or ground.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	
June 30—	*Pounds.*		*Long tons.*		*Pounds.*			
1867	....	....	428	$14,373	924,431	$38,131	....	$52,504
1868	....	....	85	4,531	834,286	33,549	....	38,080
1869	....	....	964	35,205	924,161	42,711	....	77,916
1870	....	....	742	25,335	644,080	29,531	....	54,866
1871	....	....	615	15,870	613,624	28,941	....	44,811
1872	....	....	1,641	41,321	804,977	36,103	....	77,424
1873	610,117	$29,706	755	26,065	343,828	15,041	$107	70,919
1874	331,580	16,216	1,281	43,886	69,890	2,167	97	62,366
1875	487,725	23,345	961	31,972	85,853	2,990	20	58,327
1876	385,246	18,999	1,395	40,027	77,382	2,533	94	61,653
1877	343,697	16,615	852	21,964	96,351	3,603	....	42,182
1878	334,291	16,359	1,475	38,454	65,068	1,754	34	56,601
1879	496,633	24,456	2,478	58,065	133,556	4,985	....	87,506
1880	411,340	20,066	3,400	76,481	223,855	9,202	145	105,894
1881	454,790	22,101	2,884	67,781	177,174	7,497	53	97,432
1882	520,214	25,314	2,765	69,432	117,008	3,708	241	98,695
1883	474,105	22,767	2,447	59,282	93,010	3,172	269	85,490
1884	143,267	5,802	4,145	121,719	513,161	21,181	188	148,890
1885	228,329	9,886	2,445	55,368	194,314	8,789	757	74,800
Dec. 31—								
1886	161,297	6,910	3,782	88,925	365,947	24,952	851	121,638
1887	367,239	14,290	2,078	45,033	*a* 144,380	6,796	2,090	68,209
1888	430,397	16,216	5,175	93,287	....	....	8,743	118,246
1889	503,347	18,937	5,234	88,727	....	....	111,302	218,966
1890	534,968	20,382	3,867	97,939	....	....	5,046	123,367
1891	90,658	3,729	2,530	67,573	....	....	....	71,302
1892	566,448	22,586	5,280	95,625	....	....	2,412	120,623
1893	516,953	20,073	5,066	103,875	....	....	3,819	127,767
1894	597,713	18,645	2,804	51,487	....	....	1,841	71,973
1895	678,761	25,066	6,803	80,386	....	....	27,586	133,038
1896	755,693	28,493	6,389	119,738	....	....	....	148,231
1897	539,176	20,865	5,213	107,655	....	....	2,211	130,531
1898	577,655	23,320	5,547	106,269	....	....	3,810	133,399
1899	728,299	29,124	7,435	116,493	....	....	11,514	157,131

a To June 30 only; since classed with grains.

GARNET.

The varieties of garnet considered in this chapter include those only which are used for abrasive purposes. Ornamental or gem varieties are included in the chapter on precious stones prepared by Mr. George F. Kunz. The localities from which abrasive garnet is obtained are: Litchfield County, Connecticut; Essex and Warren Counties, New York, and Delaware County, Pennsylvania. The Delaware County

(Pennsylvania) product is known commercially as garnet sand, to distinguish it from the larger crystals and massive garnet from the other localities. The quality of the material from the several localities varies considerably, the price ranging, according to quality, from $20 to $45 per ton at the mines. The production as reported to the Survey for 1899 amounted to 2,765 short tons, valued at $98,325, against 2,967 short tons, worth $86,850, in 1898. The production since 1894, the first year for which statistics were obtained, has been as follows:

Production of abrasive garnet for six years.

Year.	Quantity.	Value.
	Short tons.	
1894	2, 401	$90, 660
1895	3, 325	95, 050
1896	2, 686	68, 877
1897	2, 554	80, 853
1898	2, 967	86, 850
1899	2, 765	98, 325

GRINDSTONES.

OCCURRENCE.

Grindstones of domestic manufacture are obtained from the sandstone deposits which extend along the shores of Lake Erie for some distance east and west of Cleveland, Ohio, and as far inland as Marietta, and on Lake Huron above Detroit, Michigan. In Mineral Resources for 1886 the methods of manufacture and use are given in detail, together with a tabular statement of the several varieties, foreign or domestic, that occur, with their special uses. Five varieties are produced in the United States—four in Ohio and one in Michigan. The four in Ohio are: (1) Berea, fine sharp grit, used especially for sharpening edge tools; (2) Amherst, soft loose grit, for edge tools and saws; (3) Independence, coarse sharp grit, for grinding springs and files and for dry grinding of castings; (4) Massillon, also coarse sharp grit, for large edge tools, springs, files, and dry castings. The Huron (Michigan) stone has a fine sharp grit, and is used for sharpening edge tools when a very fine edge is required.

PRODUCTION.

With the exception of 1882 the value of the grindstones produced in 1899 was the largest in the history of the grindstone industry. The statement of production in 1882 was based on "estimates" furnished

by correspondents familiar with the industry. It is probable that such estimates were exaggerated, and that the record for maximum production belongs to 1899. There is no way of correcting the estimates for the earlier years, however, and last year must stand as second to 1882.

Compared with 1898 the value of the grindstones produced in 1899 exhibits an increase of $185,817 or 38 per cent.

In making their reports of production to the Survey, some manufacturers use the ton as a unit of measurement and others state the number of grindstones made and sold, and until 1898 no separation of quantity was attempted. Last year the manufacturers who stated the number of grindstones sold reported a product aggregating 6,300 pieces, valued at $69,776. The product reported by weight amounted to 50,644 short tons, valued at $605,810. Reporting the imports of grindstones, the Bureau of Statistics of the Treasury Department also limits the statements to the value, no figures relating to quantities having been published since 1883. The value of the grindstones imported during the decade ending December 31, 1898, averaged 15 per cent of the domestic product; in 1899 it was less than 10 per cent.

In the following table is shown the value of grindstones produced in the United States since 1880:

Value of grindstones produced in the United States, 1880 to 1899.

Year.	Value.	Year.	Value.
1880	$500,000	1890	$450,000
1881	500,000	1891	476,113
1882	700,000	1892	272,244
1883	600,000	1893	338,787
1884	570,000	1894	223,214
1885	500,000	1895	205,768
1886	250,000	1896	326,826
1887	224,400	1897	368,058
1888	281,800	1898	489,769
1889	439,587	1899	675,586

PULPSTONE.

The manufacture of paper from wood pulp has called for a stone suited to the grinding of wood pulp, resulting in the production in 1899 of 288 tons of "pulp" stones, valued at $8,712.

IMPORTS.

The amount and value of grindstones imported into the United States since 1868 are as follows:

Grindstones imported and entered for consumption in the United States, 1868 to 1899, inclusive.

Year ending—	Finished.		Unfinished or rough.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Long tons.*		
June 30, 1868		$25,640		$35,215	$60,855
1869		15,878		99,715	115,593
1870		29,161		96,444	125,605
1871	385	43,781	3,957.15	60,935	104,716
1872	1,202	13,453	10,774.80	100,494	113,947
1873	1,437	17,033	8,376.84	94,900	111,933
1874	1,443	18,485	7,721.44	87,525	106,010
1875	1,373	17,642	7,656.17	90,172	107,814
1876	1,681	20,262	6,079.34	69,927	90,189
1877	1,245	18,546	4,979.75	58,575	77,121
1878	1,463	21,688	3,669.41	46,441	68,129
1879	1,603	24,904	4,584.16	52,343	77,247
1880	1,573	24,375	4,578.59	51,899	76,274
1881	2,064	30,288	5,044.71	56,840	87,128
1882	1,705	30,286	5,945.61	66,939	97,225
1883	1,755	28,055	6,945.63	77,797	105,852
1884					a 86,286
1885					50,579
Dec. 31, 1886					39,149
1887					50,312
1888					51,755
1889					57,720
1890					45,115
1891					21,028
1892					61,052
1893					59,569
1894					52,688
1895					54,276
1896					66,195
1897					49,496
1898					62,973
1899					63,852

a Since 1884 classed as finished or unfinished.

CANADIAN PRODUCTION.

The Geological Survey of Canada gives the following statement of the production of grindstones in the Dominion since 1886:

Production of grindstones in Canada since 1886.

Calendar year.	Quantity.	Value.
	Short tons.	
1886	4,000	$46,545
1887	5,292	64,008
1888	5,764	51,129
1889	3,404	30,863
1890	4,884	42,340
1891	4,479	42,587
1892	5,283	51,187
1893	4,600	38,379
1894	3,757	32,717
1895	3,475	31,932
1896	3,663	32,810
1897	4,572	42,340
1898	....	39,465
1899	4,511	43,265

INFUSORIAL EARTH.

The abrasives included under this head consist of those porous siliceous earths of organic origin known as tripoli, diatomaceous earth, and infusorial earth. They are used to some extent in the manufacture of polishing powders and soaps, for which reason they are included among the abrasive materials. Their field is not limited to that use, however. Owing to the porous nature of infusorial earth it has been found to make an excellent absorbent for the manufacture of dynamite from nitroglycerin, and its nonconductivity of heat recommends it as a packing for boilers, steam pipes, and safes. The production in 1899 was 3,302 short tons, valued at $25,302, an increase from 2,733 short tons in 1898, valued at $16,691.

The amount and value of the product of infusorial earth for the years they have been obtained since 1880 are shown in the following table:

Production of infusorial earth from 1880 to 1899.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	1,833	$45,660	1890	2,532	$50,240
1881	1,000	10,000	1891		21,988
1882	1,000	8,000	1892		43,655
1883	1,000	5,000	1893		22,582
1884	1,000	5,000	1894	2,584	11,718
1885	1,000	5,000	1895	4,954	20,514
1886	1,200	6,000	1896	3,846	26,792
1887	3,000	15,000	1897	3,833	22,385
1888	1,500	7,500	1898	2,733	16,691
1889	3,466	23,372	1899	3,302	25,302

TRIPOLI.

Including the product from Newton County, Missouri, which for want of a better name is called tripoli, the output in 1899 amounted to 1,032 short tons of crude earth. In addition to this, 300 pounds of refined material was produced at Framingham, Massachusetts. The total value of the product from all sources was $11,730.

OILSTONES, WHETSTONES, ETC.

PRODUCTION.

The rough material from which our oilstones, etc., are made is obtained from various localities in the United States. The finer grades of oilstones are made from two grades of novaculite quarried in the vicinity of Hot Springs, Arkansas, and known, respectively, as "Arkansas" and "Washita" stone. Fine-grained sandstone, called "Hindostan" or "Orange" stone, from Orange County, Indiana; Lake Superior stone, quarried in Cuyahoga County, Ohio, and a similar material, known as Labrador stone, from Cortland County, New York, and chocolate stone, from Lisbon, New Hampshire, are used for whetstones. Scythestones and rubstones are made from Indian Pond and Lamoille stone, quarried in Grafton County, New Hampshire, and Orleans County, Vermont; from Berea, Ohio, grit (which also furnishes grindstones), and from some of the Indiana sandstone.

The value of the oilstones and whetstones made in the United States was the maximum in our history. As compared with 1898, there was an accentuated value of $27,797, or 15 per cent.

In the following table, showing the value of the product of oilstones, whetstones, etc., from 1891 to 1899, inclusive, the value is given for the finished stones, that being the condition in which the materials are marketed. For the past nine years the industry, particularly in Arkansas, has been largely controlled by one concern, the Pike Manufacturing Company, of Pike Station, New Hampshire, who operate the quarries as owners or by lease, and manufacture the stones, so that there is for the greater part of the product no marketing of crude rock.

Value of oilstones, whetstones, etc., produced in the United States since 1891.

Year.	Value.
1891	$150,000
1892	146,730
1893	135,173
1894	136,873
1895	155,881
1896	127,098
1897	149,970
1898	180,486
1899	208,283

From 1880 to 1890, inclusive, the product and value of the rough stone has been published in these reports, exception being made in the case of the output for 1890, when the value for the unfinished product was given for the novaculite of Arkansas, and in all other cases the value of the finished stones is quoted. The annual production from 1880 to 1890 was as follows:

Product of oilstones and whetstones from 1880 to 1890.

Year.	Quantity.	Value.
	Pounds.	
1880	420,000	$8,000
1881	500,000	8,580
1882	600,000	10,000
1883	600,000	10,000
1884	800,000	12,000
1885	1,000,000	15,000
1886	1,160,000	15,000
1887	1,200,000	16,000
1888	1,500,000	18,000
1889	5,982,000	32,980
1890	....	69,909

KINDS OF OILSTONES IN USE.

The Pike Manufacturing Company has issued a pamphlet containing a historical sketch of the oilstone industry and other interesting information on the selection and care of edged-tool sharpeners. The following description of the oilstones now commonly in use has been excerpted from the pamphlet as being of interest in connection with the statistics of production and consumption.

The oilstones commonly in use at the present time are the Washita, Arkansas, Turkey, and Hindostan.

ARKANSAS AND WASHITA STONES.

The Arkansas and Washita stones are quarried in the State of Arkansas, near the celebrated Hot Springs. They are found in parallel veins, or "mineral leads," and are quite similar in general appearance, both being white, or nearly so, but the Arkansas is much harder, more compact, and finer grained than the Washita. There are various grades of Arkansas and Washita rock, ranging from a perfect, fast-cutting grit to the vitreous, flinty rock that is practically worthless.

To the ordinary observer the appearance of the good stone and the worthless is nearly the same. At frequent periods since these stones first came onto the market inferior grades have been put out by irresponsible or inexperienced manufacturers, which has done serious injury to their reputation in some localities. For the past few years, however, on account of the care taken to select and manufacture only the best quality of rock, both reputation and demand have rapidly increased.

The Arkansas stone is found in two grades, known as hard and soft.

Hard Arkansas is composed of nearly 99½ per cent pure silica (one of the hardest, sharpest-cutting minerals) and is about 16 times harder than ordinary marble. Steel will not scratch it, but it, in turn, will cut the hardest steel rapidly. It is white or bluish white in color, and by reason of its fine, hard grit is particularly adapted to sharpening fine tools requiring keen, smooth edges, such as are used by engravers, watchmakers, die sinkers, wood and ivory carvers, surgeons, etc.

Owing to the limited supply of good Arkansas rock, and to the great difficulty in quarrying and manufacturing it (about 85 per cent being waste), it is necessarily high priced, a first quality stone being worth about $2.50 per pound at retail. A stone of extra large size or special shape is worth even more than this. Though these prices may seem high, they do not represent an unreasonable profit to the manufacturer who is careful to send out only the best quality of finished stones and who has to throw away many thousands of pounds of poor stones every year.

Soft Arkansas oilstone is of the same mineral composition as the hard, but is more porous; hence does not impart quite so fine an edge. It is used very largely by machinists, workers in hard wood, cutlers, and mechanics in general as a finishing stone. It is carried in stock by most tool dealers and generally sells at about one-third less price than hard Arkansas.

The Washita oilstone is the most widely used by carpenters and joiners. It has crowded the Turkey stone almost entirely out of America, and is fast superseding it in Europe and other countries. It is composed of nearly pure silica, but is much more porous than the Arkansas stone. It is stated that a cubic inch of perfectly crystallized Washita stone contains over 8,000,000 cavities or pores. It is the presence of this vast quantity of evenly distributed pores which enables the grit grains or crystals (the teeth of the stone) to work freely and thus make it the fastest cutting fine-grained stone in the world.

There is no oilstone for the proper selection of which greater experience is required than the Washita, for it can be found in all degrees of hardness and fineness. For ordinary carpenters' tools, such as plane bits, chisels, gouges, etc., a medium soft, even grained, fast cutting Washita should be chosen.

The difference between a hard and soft Washita can be told in several ways: First, by the sight; in a soft stone the minute pores are usually apparent to the eye and the surface of the stone will have an open, granulated appearance. Second, by scratching with a knife blade; a soft stone can be quite readily scratched on the edges, whereas a hard stone will show little impression. An experienced hand can tell also by drawing the thumb nail across the face of the stone, as the soft, sharp-gritted stone will "bite" or take hold of the nail much sharper than a hard stone. This is a good way to tell the coarseness of any oilstone, as a coarse stone will leave rough scratches on the nail, while a find one will cut it away smoothly. Third, by the sound; hold the stone loosely by one end between the thumb and forefinger and tap it with a knife, light hammer, or any metal substance. A soft stone will sound dead, like wood; whereas a hard stone gives forth a metallic ring. The dead, dull sound shows that the stone is porous, whereas the hard, metallic sound indicates a solid, more dense texture.

The Washita stone is put on the market in several qualities. The best is the lily white; next in order are the No. 1 and No. 2 qualities. Each of these qualities is made in all shapes and sizes required for sharpening different kinds of tools.

The lily white brand, or quality, is selected by experts from the very best rock; each stone is tested and labeled, to tell whether it is a soft, medium coarse or a hard, medium fine grit. Every lily white

stone, whether of the coarse or fine selection, is of uniform grit throughout, free from hard or soft spots or streaks, and of sharp cutting grit. Each stone is perfectly white, carefully finished, and bears two labels, one on the end, telling whether it is coarse or fine grit, and a guaranty label. The manufacturers warrant each stone to be just what it is labeled, and to give absolute satisfaction; hence neither the dealer nor the mechanic takes any risk on the stone, as it will be replaced free of charge, if not satisfactory.

The No. 1 quality Washita is a well-finished stone, free from cracks, quartz, or noticeable imperfections. It is the most largely used brand on account of its lower price, but as there are both hard and soft stones in this grade, and they are not labeled nor warranted, the stone should be selected by a thoroughly experienced judge.

The No. 2 quality Washita is, as its name would imply, a second quality stone. It usually contains some quartz streaks, sand holes, or other imperfections, but always has one or more serviceable faces, and many very excellent cutting stones can be found in this grade, if selected by an experienced hand.

In addition to the above-named grades of Washita stone, there is also a brand known as the rosy red, which is very similar in cutting qualities to the lily white, except that it is generally a little softer and coarser. This stone is streaked with orange or dull red color, which in no way affects the grit, but indicates a soft, porous nature. It is a guaranteed brand, and is well adapted for grinding down dull tools or wherever rapid work is required.

The prices of Washita stone vary widely in different sections of the country, but as a rule a No. 1 stone about 8 inches long by 2 inches wide and 1 inch thick, regular size, can be bought at from 50 to 65 cents, and the lily white from 75 cents to $1. The same stones are sold mounted in polished hard-wood boxes at an advance of 15 to 20 cents. It is better to buy them this way when possible, as a stone lasts longer and keeps in better condition in a box than loose. In buying an oil stone of any kind, price should always be a secondary consideration. A good stone will very quickly make up the difference in price over a poor one in its quicker, more efficient work. Furthermore, a good stone will last for many years if rightly used, whereas the sooner a poor stone is thrown away the better.

TURKEY STONES.

The Turkey oilstone was the leading oilstone for mechanics' tools for many centuries previous to the discovery of the Washita. It is bluish gray in color, with frequent white spots and streaks. It is composed of about 70 per cent silica, mingled with 30 per cent lime, clay, and iron. The white spots and lines are calcite, or lime, which wear away quickly, leaving holes and rough cavities in the stone. The stone

also frequently comes apart in these lines as soon as it is oil soaked. It is nearly impossible to get a perfect Turkey stone, that is, one which is free from these lime streaks or other imperfections. A good Turkey stone will impart a fine edge, but no finer than a fine-grained Washita, while it does not cut steel so fast. It sells for about the same price as lily white Washita, but very few Turkey stones are now sold in America.

HINDOSTAN STONE.

The Hindostan, although usually called an oilstone, can be used with water with equally good results. It is a very fine-grained sandstone, and is considered the best low-priced sharpening stone for mechanics' tools. Its cutting qualities are due to small grains of silica, which are remarkably uniform in size in this stone. It is a fast-cutting stone, but owing to its softness the powder or grit which is cut from the stone soon forms a mud that clogs the pores and makes it cut more slowly unless the stone is kept free by the plentiful use of water. By using a little oil and leaving this dust on top of the stone a surface is given the stone which produces a fine edge on the tool. It is a good stone for imparting a quick, medium-coarse edge, and is used largely by amateurs and those who do not have to use an oilstone very often. It is sold in three grades, as follows:

Export extra quality, which is the finest grained, hardest Hindostan, white or yellowish white in color; Washita-finish quality, which is well finished, grayish white stone; and the No. 1 quality, which is generally a very roughly finished stone and varies in color from a bluish gray to almost a yellow. Hindostan stones generally retail at from 10 to 35 cents apiece, according to size and quality.

OTHER OILSTONES.

In addition to those already mentioned, there are many other oilstones more or less known to the American trade. Among those now on the market are the Queer Creek, Chocolate, Deerlick, and several kinds of emery and corundum oilstones.

The Queer Creek is a hard, medium coarse-grained sandstone, quarried in Ohio, dark gray in color, and suitable only for grinding down dull tools or sharpening those intended for coarse work. It is inclined to glaze unless used with care, and works fully as well with water as with oil.

The Chocolate is a fine-grained mica-schist of a bluish-chocolate color. It is a little softer than the Queer Creek, and a very fast-cutting stone. It imparts a medium-coarse edge, and is especially adapted for sharpening leather and skinning knives. It is also used quite largely for sharpening cloth cutters' tools, kitchen and carving knives, pocketknives, and similar implements. It can be used dry, or

with oil or water, and is perhaps the best stone on the market where a quick, medium-coarse edge is required. It can be found in most hardware stores, and sells for about the same price as No. 1 quality Washita.

The Deerlick is practically the same as the Queer Creek in appearance and sharpening qualities. The Queer Creek and Deerlick are generally sold a little lower than the No. 1 Washita.

IMPORTS.

The following table shows the total value of all kinds of hones and whetstones imported since 1880:

Imports of hones and whetstones since 1880.

Year ending—	Value.	Year ending—	Value.
June 30, 1880	$14, 185	Dec. 31, 1890	$37, 454
1881	16, 631	1891	35, 344
1882	27, 882	1892	33, 420
1883	30, 178	1893	25, 301
1884	26, 513	1894	26, 671
1885	21, 434	1895	32, 439
Dec. 31, 1886	21, 141	1896	50, 588
1887	24, 093	1897	34, 485
1888	30, 676	1898	30, 856
1889	27, 400	1899	34, 510

QUARTZ CRYSTAL.

The product of quartz crystal for wood finishing amounted in 1899 to 13,600 short tons, valued, crude, at $39,000, against 8,312 short tons, valued at $23,990 in 1898, and 7,500 short tons, worth $22,500, in 1897.

Production of quartz crystal since 1894.

Year.	Quantity.	Value.
	Short tons.	
1894	6, 024	$18, 054
1895	9, 000	27, 000
1896	6, 000	18, 000
1897	7, 500	22, 500
1898	8, 312	23, 990
1899	13, 600	39, 000

CRUSHED STEEL.

The production of crushed steel by the Pittsburg Crushed Steel Company in 1899 amounted to 675,000 pounds, valued at $47,250, against 660,000 pounds, worth $46,200, in 1898. The comparatively small increase in 1899 was due to the demoralized condition of the building trades during the greater part of the year, due to conflicts between the labor unions and the contractors. The bulk of the crushed steel sold is used in the stone-cutting trade, particularly by the marble and granite cutters, although considerable quantities are used by lens workers and other glass grinders. For the latter purpose the fine grades known as steel emery and rouge are used. The Pittsburg Crushed Steel Company reports that it has recently developed a trade with railroad and other machine shops who are using the material for throttle and other valve grinding.

CARBORUNDUM.

The production of corborundum, or carbide of silicon, by the Carborundum Company of Niagara Falls, New York, in 1899, was 1,741,245 pounds against 1,594,152 pounds in 1898. The value of the product in 1899 was $139,000 against $150,000 in 1898. The average price per pound in 1899 was 8 cents.

PHOSPHATE ROCK.

By Edward W. Parker.

PRODUCTION.

The phosphate-rock industry in 1899 was marked by considerable increases in production in Florida and Tennessee, decreased production in South Carolina, a notable advance in the values of Tennessee rock, and the beginning of a phosphate-mining industry in Pennsylvania. In Florida the increase in production was shared by the miners of hard rock, land pebble, and river pebble. No production of soft rock was reported in either 1898 or 1899. The decrease in South Carolina was in the production of land rock, which fell off nearly 75,000 tons, and was only partly made up by an increase of over 30,000 tons in the production of river rock. Tennessee's production increased 37½ per cent. Pennsylvania entered the phosphate industry with an output of 2,000 tons.

The total amount of phosphate-rock production reported to the Survey in 1899 was 1,515,702 long tons, valued at $5,084,076, as compared with 1,308,885 long tons in 1898, valued at $3,453,460, indicating an increase of output in 1899 of 206,817 long tons and of $1,630,616 in value. The distribution of this product, by States and grades of rock, for 1899 and for the eight preceding years is presented in the following table:

Production of phosphate rock from 1891 to 1899.

State.	1891.		1892.		1893.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Florida:	*Long tons.*		*Long tons.*		*Long tons.*	
Hard rock			*a*155,908	$859,276	215,685	$1,117,732
Soft rock	57,982	....	6,710	32,418	13,675	64,626
Land pebble			21,905	111,271	86,624	359,127
River pebble	54,500	....	*b*102,820	415,453	122,820	437,571
Total	112,482	$703,013	287,343	1,418,418	438,804	1,979,056
South Carolina:						
Land rock	344,978	2,187,160	243,653	1,236,447	308,435	1,408,785
River rock	130,528	760,978	150,575	641,262	194,129	748,229
Total	475,506	2,948,138	394,228	1,877,709	502,564	2,157,014
Grand total	587,988	3,651,151	681,571	3,296,127	941,368	4,136,070

a Includes 52,708 tons of hard rock carried over in stock from 1891.

b Includes 12,120 tons of river pebble carried over in stock from 1891.

Production of phosphate rock from 1891 to 1899—Continued.

State.	1894.		1895.		1896.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Florida:	*Long tons.*		*Long tons.*		*Long tons.*	
Hard rock	326,461	$979,383	307,098	$1,302,096	296,811	$1,067,525
Soft rock			6,916	32,000	400	2,300
Land pebble	98,885	296,655	181,011	593,716	97,936	176,972
River pebble	102,307	390,775	73,036	185,090	100,052	300,556
Total	527,653	1,666,813	568,061	2,112,902	495,199	1,547,353
South Carolina:						
Land rock	307,305	1,252,768	270,560	898,787	267,072	792,457
River rock	142,803	492,808	161,415	512,245	135,351	389,192
Total	450,108	1,745,576	431,975	1,411,032	402,423	1,181,649
Tennessee	19,188	67,158	38,515	82,160	26,157	57,370
North Carolina					7,000	17,000
Grand total	996,949	3,479,547	1,038,551	3,606,094	930,779	2,803,372

State.	1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Florida:	*Long tons.*		*Long tons.*		*Long tons.*	
Hard rock	360,147	$1,063,713	366,810	$1,396,108	460,297	$2,119,130
Soft rock	2,300	4,600				
Land pebble	92,132	180,794	155,084	293,688	177,170	515,458
River pebble	97,763	244,408	79,000	158,000	88,953	169,473
Total	552,342	1,493,515	600,894	1,847,796	726,420	2,804,061
South Carolina:						
Land rock	267,380	748,050	298,610	856,225	223,949	738,969
River rock	90,900	238,522	101,274	251,047	132,701	339,130
Total	358,280	986,572	399,884	1,107,272	356,650	1,078,099
Tennessee	128,723	193,115	308,107	498,392	430,192	1,192,916
North Carolina					440	(*a*)
Pennsylvania					2,000	9,000
Grand total	1,039,345	2,673,202	1,308,885	3,453,460	1,515,702	5,084,076

a Value included in South Carolina land rock.

From the foregoing table it is seen that while the product increased 206,817 long tons, or a little less than 16 per cent, the value shows a gain of $1,630,616, or 47 per cent. With the exception of Florida river pebble, the price of every grade of rock advanced in 1899. The average price of hard rock advanced from $3.81 in 1898 to $4.60 in 1899; land pebble advanced from $1.89 to $2.91; South Carolina land rock, from $2.87 to $3.30; and river rock from $2.48 to $2.56. The

most notable advance was in the price of Tennessee rock, from $1.62 to $2.77. The reason for this advance in Tennessee rock, apart from the sympathy felt in the general advance in prices during 1899, was the improvements made in the preparation of the material for market. Prior to last year the product was crudely prepared, and the cost and market value were low compared with other rock. During the last year extensive plants for the preparation of the product were completed, and the grade of the marketed material and the prices have improved in consequence.

The improved condition of the phosphate industry in 1899 led to the opening of many new mines in Tennessee, the reopening of old properties in Florida, and to extensive prospecting work in both States. At the close of the year history was found to have repeated itself and there was reason to recall the crash that followed the boom in Florida several years ago. During the past year the market reports were uniformly favorable, the demand being fairly active and prices firm, with a rising tendency until late in the year. It was then found that the mining and prospecting activity, and particularly the misleading newspaper items promising enormous increases in production, had impressed foreign buyers with the idea that an overproduction, with the attendant slump in prices, was to be looked for, and orders fell off in anticipation of the decline. Against this condition is set the rumors of consolidations and the efforts of large interests to keep the situation in control. The Virginia-Carolina Chemical Company has secured control of many of the South Carolina properties, and it is said that similar action is contemplated by large interests in Florida and Tennessee, in order to protect the industry in those States, obviate the threatened sacrifice of a valuable product, and prevent a recurrence of the disastrous conditions which brought ruin to many promising mines in Florida five or six years ago.

The depression in values brought about by the large production in Florida in 1893, 1894, and 1895 is exhibited in the following table. Up to 1892, when South Carolina was the chief source of supply, prices had continued comparatively steady at from $5 to $6 per ton. In 1893, when the Florida production brought the total up to 40 per cent over that of 1891, the fall in prices began and the average for that year was about $4.40. In 1895 it had dropped to about $3.50 and in 1897 to about $2.50. The low price in 1897 was partly due to the bringing in of the Tennessee product which in that year sold for $1.50 per ton. The business revival of 1898 and 1899 was felt in the phosphate industry, for in spite of larger tonnage each year than ever before the price in 1898 recovered to $2.64 per ton, and advanced again in 1899 to $3.35 per ton.

Since 1880 the amount and value of the phosphate rock produced in the United States have been as follows:

Production of phosphate rock in the United States since 1880.

Year.	Production.	Value.	Year.	Production.	Value.
	Long tons.			*Long tons.*	
1880....	211, 377	$1, 123, 823	1890....	510, 499	$3, 213, 795
1881....	266, 734	1, 980, 259	1891....	587, 988	3, 651, 150
1882....	332, 077	1, 992, 462	1892....	681, 571	3, 296, 227
1883....	378, 380	2, 270, 280	1893....	941, 368	4, 136, 070
1884....	431, 779	2, 374, 784	1894....	996, 949	3, 479, 547
1885....	437, 856	2, 846, 064	1895....	1, 038, 551	3, 606, 094
1886....	430, 549	1, 872, 936	1896....	930, 779	2, 803, 372
1887....	480, 558	1, 836, 818	1897....	1, 039, 345	2, 673, 202
1888....	448, 567	2, 018, 552	1898....	1, 308, 885	3, 453, 460
1889....	550, 245	2, 937, 776	1899....	1, 515, 702	5, 084, 076

FLORIDA.

Phosphate-rock mining in Florida has been the development of the last twelve years. In Mineral Resources for 1888 announcement was made of the discovery of large beds of phosphate rock rich in phosphoric acid, and a product of 3,000 long tons in the State was reported. The next two years were devoted largely to speculation and development. There was much "boom" excitement. Fancy prices were asked and given for any land that showed indications of phosphate rock, without regard to the grade of the material, and conditions around Ocala were not dissimilar to those which prevailed at Birmingham, Alabama, in the boom days of that city. Meanwhile production developed, the marketed product increasing from 3,000 long tons in 1888 to 4,100 tons in 1889 and 46,501 tons in 1890. In 1891 the product had risen to 112,482 long tons and the value of the product was given at $703,013. In the previous year the value was placed at $338,190, which was more than the value of the total mineral product of the State exclusive of phosphate rock. Up to this time (1891) no effect on prices had been observed, the average value per ton being from $6 to $7. In 1892 the product rose to 287,343 long tons, and about this time foreign buyers discovered that much of the Florida rock being shipped was of low grade. It became necessary to sell rock on its chemical analysis. The large amount of low-grade material put upon the market, together with the increased production, which proved to be in excess of the market requirements, had the effect of demoralizing prices, which for Florida rock dropped to $5 per ton in 1892, to $4.50 in 1893, and to $3 in 1894. Florida miners seemed to think

that the market would absorb any kind of rock in any amount, and as a result of these conditions the reaction was a severe one. Prices fell below what was in many cases the actual cost of production, and assignments, receiverships, and foreclosure sales were frequent.

Probably not more than 25 per cent of the companies organized during the boom days survived the storms, and it is doubtful if the value of the rock produced in the past twelve years has equalled the amount of money invested in phosphate plants and lands.

As has already been stated, the conditions at the close of the year 1899 recalled the disastrous period of 1894 and 1895. Following this period the industry settled down to a steadier and more substantial basis, the stronger companies which survived, or were reorganized after the storm, being able to handle large quantities of material with a reasonable profit, though prices had not materially improved. The industrial revival of 1899, with active demand for rock, and improved prices led to a renewal of prospecting for new mines and opening of old ones. The natural result of offering to foreign markets the prospects of an overproduction during 1900, was a falling off in demand and depressed prices at the close of 1899, quite in contrast to the firm tone which prevailed during the year.

In the following table are presented the statistics of production in Florida since 1888.

Production of phosphate rock in Florida since 1888.

Year.	Long tons.	Value.	Year.	Long tons.	Value.
1888....	3,000	$21,000	1894....	527,653	$1,666,813
1889....	4,100	28,000	1895....	568,061	2,112,902
1890....	46,501	338,190	1896....	495,199	1,547,353
1891....	112,482	703,013	1897....	552,342	1,493,515
1892....	287,343	1,418,418	1898....	600,894	1,847,796
1893....	438,804	1,979,056	1899....	726,420	2,804,061

The distribution of this product, according to the kinds of rock, is shown in a preceding table.

In the reports made to the United States Geological Survey the production of hard rock in Florida during 1899 aggregates 460,297 long tons. According to the interesting summary of the Florida phosphate trade issued through the enterprise of Messrs. Auchincloss Brothers, of New York City, the shipments of high-grade phosphate rock in 1899 amounted to 444,675 long tons. This would indicate a surplus in the production in 1899 of 15,622 long tons. In addition to this it is known that in a number of cases stocks, accumulated in the period of overproduction at mines which have been idle for two or

three years, were drawn upon to supply the accentuated demand created by the prosperous times of 1899. As previously stated, some of these idle properties were added to the productive list last year. The available supply thus augmented is responsible for the reaction already noted as having taken place at the close of the year.

The shipments of high-grade phosphate rock since 1894, as collated by Auchincloss Brothers, are shown in the following table. The totals will be found to agree very closely with the statistics of production collected independently by the Survey. The differences in the totals for the past six years aggregate only 29,000 tons—less than 1.4 per cent.

Total shipments of Florida hard-rock phosphate, by months, since 1894.

[Long tons.]

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	16,526	15,780	16,996	12,924	11,682	28,560
February	4,111	17,252	16,853	20,668	26,850	32,630
March	34,126	31,283	37,155	37,243	34,049	43,051
April	36,533	41,445	36,559	32,608	22,274	59,001
May	30,780	45,053	45,846	45,715	31,992	48,584
June	29,818	31,027	16,511	32,837	31,948	23,051
July	46,855	21,284	15,296	22,639	53,114	48,747
August	37,823	14,588	19,914	19,292	27,409	41,155
September	34,032	25,388	25,116	59,966	46,961	35,728
October	19,732	27,783	30,605	27,664	21,476	36,694
November	7,683	18,160	38,402	20,184	30,595	28,947
December	6,060	17,003	23,618	18,537	22,155	18,527
Total	304,079	306,046	322,871	350,277	360,505	444,675

The following is the record of shipments to each country for the last six years:

Shipments of Florida hard-rock phosphate, by countries.

[Long tons.]

Country.	1894.	1895.	1896.	1897.	1898.	1899.
England	45,455	27,007	20,533	24,163	23,849	31,789
Scotland	8,144	3,054	1,038	5,957	6,000	9,545
Ireland	6,737	3,867	513	2,953	3,420	....
Germany	153,526	145,377	151,461	181,355	186,731	243,887
Belgium	....	7,033	27,214	22,954	38,903	37,103
Holland *a*	47,465	52,724	47,235	53,039	64,309	87,167
Denmark	7,726	6,735	9,594	11,019	8,287	5,475

a A large proportion of the shipments to Rotterdam are forwarded to the interior of Germany.

Shipments of Florida hard-rock phosphate, by countries—Continued.

[Long tons.]

Country.	1894.	1895.	1896.	1897.	1898.	1899.
Norway and Sweden	7,940	9,304	12,534	7,442	9,378	11,938
France	12,101	23,534	6,986	13,931	....	3,165
Italy	13,810	21,615	32,999	16,931	11,040	4,546
Russia	....	....	1,607	3,613	....	1,700
Austria	700	3,871	2,494	4,505	4,946	....
United States, West Indies, Australia, etc	475	1,925	8,663	2,415	3,642	8,360
Total...	304,079	306,046	322,871	350,277	360,505	444,675

The following are the details of all shipments to each port:

Destination of shipments of Florida hard-rock phosphate, by ports.

[Long tons.]

Port.	1894.	1895.	1896.	1897.	1898.	1899.
UNITED KINGDOM.						
London	13,970	7,071	6,382	9,058	3,694	6,310
Liverpool	3,053	6,475	8,423	11,295	15,878	20,029
Birkenhead	5,724	2,446	2,442	....	....	....
Garston	16,987	4,706	....	....	....	5,450
Hull	....	....	1,130	....	....	....
Newcastle	5,721	4,363	2,156	2,316	4,277	....
Bo'ness	2,838	....	....	....	2,306	2,400
Glasgow	2,070	2,209	....	2,174	3,010	4,831
Aberdeen	836	845	1,038	1,495	684	2,314
Dublin	3,689	1,548	513	1,476	2,420	....
Cork	1,076	1,218	....	1,477	1,000	....
Belfast	1,972	1,101	....	....	....	....
Leith	2,400	....	....	2,288	....	....
Ipswich	....	....	....	1,494	....	....
Felixstowe	....	850	....	....	....	....
Silloth	....	1,096	....	....	....	....
Total.........	60,336	33,928	22,084	33,073	33,269	41,334

Destination of shipments of Florida hard-rock phosphate, by ports—Continued.

[Long tons.]

Port.	1894.	1895.	1896.	1897.	1898.	1899.
BALTIC.						
Aarhuus	2, 118	773	3, 217	4, 917	2, 214	2, 250
Kastrup	5, 608	5, 962	6, 377	6, 102	6, 073	5, 475
Landskrona	2, 680	2, 952	8, 441	3, 110	3, 185	5, 700
Gothenburg	2, 630	3, 927	2, 771	1, 285	4, 025	3, 083
Stockholm	2, 630	2, 425	1, 322	3, 047	....	....
Stettin	46, 380	55, 016	60, 977	63, 437	71, 047	84, 916
Danzig	4, 331	1, 842	2, 215	....	2, 569	1, 700
Memel	2, 184	4, 200	2, 981	10, 135	9, 281	10, 250
Frederichstadt	....	3, 819	....	....	....	....
Riga	....	....	1, 607	....	....	....
Libau	....	....	....	3, 613	....	....
Gaeddviken	....	....	....	....	2, 168	3, 155
Legan	....	....	....	....	....	1, 700
Total	68, 561	80, 916	89, 908	95, 646	100, 562	118, 229
CONTINENTAL.						
Rotterdam	47, 465	52, 724	42, 204	50, 548	61, 289	82, 099
Antwerp	....	2, 805	14, 632	8, 716	23, 160	19, 027
Ghent	....	1, 818	12, 582	14, 238	15, 743	18, 076
Hamburg	61, 712	62, 975	58, 772	82, 765	75, 798	103, 313
Harburg	24, 297	12, 894	10, 789	5, 378	....	....
Bremen	....	1, 653	13, 700	19, 640	28, 036	39, 873
Geestemunde	14, 622	2, 978	2, 027	....	....	1, 585
La Pallice	....	5, 692	....	2, 740	....	....
Delfzyl	....	....	1, 738	....	....	....
Dordrecht	....	....	3, 293	....	....	....
Ostend	....	2, 410	....	....	....	....
Bordeaux	2, 953	....	....	....	....	....
Tounay Charente	1, 025	....	....	....	....	....
Zwyndrecht	....	....	....	2, 491	3, 020	5, 068
Total	152, 074	145, 949	159, 737	186, 516	207, 046	269, 041
MEDITERRANEAN.						
Cette	1, 132	6, 055	....	7, 746	....	3, 165
St. Louis du Rhone	6, 991	9, 159	3, 207	2, 354	....	....
Marseilles	....	2, 030	....	1, 091	....	....
Venice	2, 181	7, 888	10, 272	5, 310	1, 800	....
Genoa	11, 629	13, 227	21, 632	11, 621	4, 975	4, 546

Destination of shipments of Florida hard-rock phosphate, by ports—Continued.

[Long tons.]

Port.	1894.	1895.	1896.	1897.	1898.	1899.
MEDITERRANEAN—continued.						
Galatz	....	....	2, 494	....	2, 754	....
Fiume	700	3, 871	....	2, 705	4, 400	....
Port le Bouc	....	....	1, 458	....	....	....
Leghorn	....	....	3, 416	....	2, 057	....
Trieste	....	....	....	1, 800	....	....
Bone	....	1, 098	....	....	....	....
Total	22, 633	43, 328	42, 479	32, 627	15, 986	7, 711
DOMESTIC, UNITED STATES, ETC.						
Cartaret	....	....	2, 950	2, 415	1, 935	1, 506
Baltimore	....	1, 920	292	....	....	....
Elizabethport	....	....	1, 920	....	....	917
Philadelphia	....	....	3, 001	....	....	....
New York	....	5	....	....	....	....
Barbados, W. I	475	....	500	....	....	....
Australia	....	....	....	....	1, 707	....
Total	475	1, 925	8, 663	2, 415	3, 642	2, 423

RECAPITULATION.

[Long tons.]

Port.	1894.	1895.	1896.	1897.	1898.	1899.
To United Kingdom ports	60, 336	33, 928	22, 084	33, 073	33, 269	41, 334
To Baltic ports	68, 561	80, 916	89, 908	95, 646	100, 562	118, 229
To Continental ports	152, 074	145, 949	159, 737	186, 516	207, 046	269, 041
To Mediterranean ports	22, 633	43, 328	42, 479	32, 627	15, 986	7, 711
Total foreign shipments	303, 604	304, 121	314, 208	347, 862	356, 863	436, 315
Total domestic shipments	475	1, 925	8, 663	2, 415	3, 642	8, 360
Total shipments	304, 079	306, 046	322, 871	350, 277	360, 505	444, 675

The substantial yearly increase in shipments shows that Florida high-grade rock continues in favor with the superphosphate manufacturers of Europe.

The following table shows the uninterrupted increase in shipments since the commencement of the industry. The statement includes the shipments for the first six months of 1900, as reported by Messrs. Auchincloss Brothers.

Total shipments of Florida hard-rock phosphates since 1890.

[Long tons.]

Year.	Tons.	Year.	Tons.	Year.	Tons.
1890	11,206	1894	304,079	1898	360,505
1891	71,682	1895	306,046	1899	444,675
1892	188,013	1896	322,871	1900, to July 1	234,982
1893	220,216	1897	350,277		

The above table shows that a total of 2,814,552 long tons of high-grade phosphate rock have been shipped, mostly to European manufacturers, during the nine and a half years of exploitation.

In addition to the growing European demand for high-grade rock, the situation in Florida has been considerably improved by the steady reduction of stocks on hand. The statistics of stocks carried forward at stated periods have been carefully compiled by Messrs. Auchincloss Brothers since 1896 and are presented in the following table:

Stocks of high-grade Florida phosphate rock at quarterly periods since 1896.

[Long tons.]

Date.	1896.	1897.	1898.	1899.
January 1	159,051	135,494	86,064	49,059
April 1	158,918	133,714	85,182	55,624
July 1	136,639	94,514	65,632	56,077
October 1	158,134	64,694	43,579	54,050

The shipments of Florida hard rock during the same period were as follows:

Shipments of high-grade Florida phosphate rock by quarterly periods since 1896.

[Long tons.]

Date.	1896.	1897.	1898.	1899.
January 1 to April 1	71,004	70,835	72,581	104,241
April 1 to July 1	98,916	111,160	86,214	130,636
July 1 to October 1	60,326	101,897	127,484	125,630
October 1 to December 31	92,623	66,385	74,226	84,168
Total	322,869	350,277	360,505	444,675

The following statements in regard to the shipments of pebble phosphate are also furnished by Messrs. Auchincloss Brothers:

Shipments of Florida pebble phosphate from 1895 to 1899.

[Long tons.]

Port.	1895.	1896.	1897.	1898.	1899.
UNITED KINGDOM.					
London	7,860	1,138	....	2,904	6,295
Liverpool	....	3,972	....	....	7,591
Birkenhead	....	....	6,576	3,100	3,729
Garston	2,261	....	2,739	....	....
Glasgow	3,360	....	2,377	....	2,245
Aberdeen	2,186	1,582	1,000	....	....
Dublin	....	1,021	....	....	2,595
Belfast	3,873	2,576	3,158	....	....
Plymouth	8,921	4,623	7,408	2,920	3,984
Kingslynn	12,003	9,019	13,046	2,185	9,748
Newport	....	....	3,000	....	....
Falmouth	....	1,200	1,830	....	....
Swansea	....	819	1,250	....	1,871
Bristol	2,724	1,813	6,000	2,780	3,148
Ipswich	6,017	4,529	....	....	....
Drogheda	....	2,694	....	....	....
Exmouth	710	....	....	....	....
Monmouth	2,574	....	....	....	....
Harwich	....	2,045	....	....	....
Padstow	436	....	....	....	....
Felixstowe	....	....	....	3,000	2,967
Bo'ness	....	....	....	....	2,506
Total	52,925	37,031	48,384	16,889	46,679
BALTIC.					
Gothenburg	....	2,020	....	....	....
Stettin	7,704	2,760	5,309	5,780	3,281
Memel	....	1,500	....	....	....
Riga	2,613	2,650	....	....	....
Helsingborg	15,298	9,495	14,834	14,242	14,849
Muhlgraben	....	....	2,500	....	....
Landskrona	....	....	....	....	1,561
Total	25,615	18,425	22,643	20,022	19,691

Shipments of Florida pebble phosphate from 1895 to 1899—Continued.

[Long tons.]

Port.	1895.	1896.	1897.	1898.	1899.
CONTINENTAL.					
Rotterdam	5,743				2,889
Hamburg	18,877	4,876	6,176		2,510
Harburg	6,532	5,501	6,405	2,910	2,600
Bremen		2,465			
La Pallice		2,180		2,106	2,883
Nantes	2,045	2,282	2,092	850	
Bordeaux	1,611	5,040	2,753		5,248
St. Nazaire		2,802		2,370	13,606
Honfleur				2,106	
Antwerp					1,575
Total	34,808	25,146	17,426	10,342	31,311
MEDITERRANEAN.					
Cette	258			2,800	6,490
St. Louis du Rhone	5,298			1,425	2,487
Marseilles				1,425	
Venice				3,339	12,963
Genoa	1,005		1,160	10,766	8,701
Port le Bouc		1,204			
Total	6,561	1,204	1,160	19,755	30,641
DOMESTIC, UNITED STATES, ETC.					
Cartaret	19,808	15,278	28,728	30,710	21,851
Baltimore	26,804	38,630	48,936	56,875	43,044
Elizabethport			827	1,015	1,530
Philadelphia	12,962	5,308	11,526	21,582	12,104
New York	3,731	5,113			
Weymouth					7,468
Newtown Creek			618		
Mantua Creek		2,473	1,752	865	
Alexandria		969	6,668	3,727	2,218
Wilmington	800	6,620	6,855	6,591	1,978
Mobile		1,725			

Shipments of Florida pebble phosphate from 1895 to 1899—Continued.

[Long tons.]

Port.	1895.	1896.	1897.	1898.	1899.
DOMESTIC, UNITED STATES, ETC.—c't'd.					
Savannah	575				
Richmond		4,406	4,908		
Norfolk		6,235	11,918		
Pensacola		1,968			
Hiogo, Japan					2,721
New Orleans		5,419			
Kobe, Japan					6,579
Yokohama, Japan				2,415	6,607
Melbourne, Australia					1,684
Total	64,680	94,144	122,736	123,780	107,784

RECAPITULATION.

To United Kingdom ports	52,925	37,031	48,384	16,889	46,679
To Baltic ports	25,615	18,425	22,643	20,022	19,691
To Continental ports	34,808	25,146	17,426	10,342	31,311
To Mediterranean ports	6,561	1,204	1,160	19,755	30,641
Total foreign shipments	119,909	81,806	89,613	67,008	128,322
Total domestic shipments	64,680	94,144	122,736	123,780	107,784
Total shipments	184,589	175,950	212,349	190,788	236,106
RIVER PEBBLE.					
Foreign shipments	67,694	45,552	46,575	24,238	40,207
Domestic shipments	8,798	29,289	60,329	44,715	44,343
Total shipments	76,492	74,841	106,904	68,953	84,550
LAND PEBBLE.					
Foreign shipments	52,215	36,254	43,038	42,770	88,115
Domestic shipments	55,882	64,855	62,407	79,065	63,441
Total shipments	108,097	101,109	105,445	121,835	151,556

PENNSYLVANIA.

During the year 1899, 2,000 long tons of phosphate rock were mined at Ross Farm, in Juniata County, Pennsylvania. Only 200 tons of this product were sold in the raw or ground state, the remainder being manufactured into superphosphates at a plant erected near the mines. According to a description of the plant published in the American Fertilizer, the establishment has a daily capacity of from 150 to 200 tons, with a storage room for 25,000 tons. It is modeled on the lines of the Savannah factory of the Southern Fertilizer Company, and was erected by the builder of the Peace River Phosphate Company's plant in Florida.

There are three principal deposits in the locality, all controlled by the same company—The Tuscarora Fertilizer Company—and known as the Ross Farm mine, the Moore Farm mine, and the Reeds Gap deposit. The two former are located on the line of the Tuscarora Valley Railroad and the latter about 5 miles distant from it. The larger portion of the material is said to be of low grade, but the higher grades are so characteristic as to enable a ready separation of the more valuable portions.

It is difficult to estimate the quantity of phosphate rock in this field that will run above 50 per cent of bone phosphate of lime. At Ross Farm a stratum of 30 feet in width has a length of 4,000 feet, with 300 feet below water line, the veins being inclined about 60° from the horizontal.

The stratum carries nodules of irregular rock, ranging from 45 to 70 per cent bone phosphate. Three levels have been opened at Ross Farm, from which at least 25 per cent of the rock mined is said to average 50 per cent or over. This would give a yield down to water level of about 300,000 tons. The matrix consists of a yellow marl, ranging from 6 to 8 per cent phosphoric acid. It is said that this marl will find a ready sale in the immediate territory and that it will bear some transportation.

At the Moore Farm deposit, about 3 miles from Ross Farm and on the railroad, the exploitable phosphate is said to be about twice that of Ross Farm, and at Reeds Gap the available phosphate will be about the same as that at Ross Farm. It is not to be expected that the Pennsylvania rock will be able to compete in distant markets with the higher grades of fertilizers from South Carolina, Tennessee, and Florida, but as the territory adjacent to the phosphate mines is largely devoted to agricultural interests, particularly fruit and grain, there should be a local demand sufficient to support the industry.

The following analyses are published in the American Fertilizer, showing the composition of two kinds of phosphate produced at Ross Farm, which consists of red nodules and white rock. In addition to these there are gray nodules, blue and black nodules, and the phosphoric marl, the composition of which is not given.

Composition of red nodules and white rock phosphate from Ross Farm, Pennsylvania.

Kind.	Phosphoric acid.	Bone phosphate.
	Per cent.	*Per cent.*
Red nodules:		
Sample 1	21.38	48.02
Sample 2	22.46	49.41
Sample 3	23.03	50.27
Sample 4	23.67	52.03
Sample 5	23.90	52.17
White rock:		
Sample 1	13.69	29.89
Sample 2	15.58	34.01
Sample 3	19.70	43.01
Sample 4	21.02	45.89
Sample 5	24.56	53.61

SOUTH CAROLINA.

The total production of phosphate rock in South Carolina since 1867 and the distribution of the shipments according to sources (land or river) are shown in the following table:

Phosphate rock mined by the land and river mining companies of South Carolina.

[Long tons.]

Year ending—	Land companies.	River companies.	Total.
May 31, 1867	6	....	6
1868	12, 262	....	12, 262
1869	31, 958	....	31, 958
1870	63, 252	1, 989	65, 241
1871	56, 533	17, 655	74, 188
1872	36, 258	22, 502	58, 760
1873	33, 426	45, 777	79, 203
1874	51, 624	57, 716	109, 340
1875	54, 821	67, 969	122, 790
1876	50, 566	81, 912	132, 478
1877	36, 431	126, 569	163, 000
1878	112, 622	97, 700	210, 322
1879	100, 779	98, 586	199, 365
1880	125, 601	65, 162	190, 763
1881	142, 193	124, 541	266, 734
1882	191, 305	140, 772	332, 077
1883	219, 202	159, 178	378, 380
1884	250, 297	181, 482	431, 779
1885	225, 913	169, 490	395, 403
Dec. 31, 1885 *a*	149, 400	128, 389	277, 789
1886	253, 484	177, 065	430, 549
1887	261, 658	218, 900	480, 558
1888	290, 689	157, 878	448, 567
1889	329, 543	212, 102	541, 645
1890	353, 757	110, 241	463, 998
1891	344, 978	130, 538	475, 516
1892	243, 652	150, 575	394, 227
1893	308, 435	194, 129	502, 564
1894	307, 305	142, 803	450, 108
1895	270, 560	161, 415	431, 975
1896	267, 072	135, 351	402, 423
1897	267, 380	90, 900	358, 280
1898	298, 610	101, 274	399, 884
1899	223, 949	132, 701	356, 650
Total	5, 965, 521	3, 703, 261	9, 668, 782

a Seven months.

In the following tables will be found statements of the shipments of South Carolina phosphate rock since 1874.

Detailed statement of total foreign and coastwise shipments and local consumption of South Carolina rock since June 1, 1874.

[Long tons.]

Period.	Shipments and consumption.	Beaufort.	Charleston.	Total.	Total for each year.
	Foreign ports....	44,617	25,929	70,546	
June 1, 1874, to May 31, 1875..	Domestic ports ..	7,000	25,560	32,560	122,790
	Consumed.......	....	19,684	19,684	
	Foreign ports....	50,384	25,431	75,815	
June 1, 1875, to May 31, 1876..	Domestic ports ..	9,400	28,831	38,231	132,896
	Consumed.......	....	18,850	18,850	
	Foreign ports....	73,923	28,844	102,767	
June 1, 1876, to May 31, 1877..	Domestic ports ..	6,285	40,768	47,053	163,220
	Consumed.......	....	13,400	13,400	
	Foreign ports....	100,619	21,123	121,742	
June 1, 1877, to May 31, 1878..	Domestic ports ..	8,217	60,729	68,946	208,323
	Consumed.......	....	17,635	17,635	
	Foreign ports....	97,799	21,767	119,566	
June 1, 1878, to May 31, 1879..	Domestic ports ..	8,618	52,281	60,899	199,365
	Consumed.......	....	18,900	18,900	
	Foreign ports....	47,157	14,218	61,375	
June 1, 1879, to May 31, 1880..	Domestic ports ..	13,346	94,002	107,348	190,763
	Consumed.......	....	22,040	22,040	
	Foreign ports....	62,200	8,568	70,768	
June 1, 1880, to May 31, 1881..	Domestic ports ..	65,895	91,929	157,824	266,734
	Consumed.......	....	38,142	38,142	
	Foreign ports....	89,581	22,905	112,486	
June 1, 1881, to May 31, 1882..	Domestic ports ..	65,340	111,314	176,654	332,077
	Consumed.......	....	42,937	42,937	
	Foreign ports....	94,789	28,251	123,040	
June 1, 1882, to May 31, 1883..	Domestic ports ..	62,175	150,545	212,720	378,380
	Consumed.......	....	42,620	42,620	
	Foreign ports....	132,114	20,539	152,653	
June 1, 1883, to May 31, 1884..	Domestic ports ..	41,040	181,363	222,403	431,779
	Consumed.......	5,800	50,923	56,723	
	Foreign ports....	111,075	11,495	122,570	
June 1, 1884, to May 31, 1885..	Domestic ports ..	44,130	161,700	205,833	395,403
	Consumed.......	12,000	55,000	67,000	
	Foreign ports....	105,761	8,581	114,342	
June 1, 1885, to Dec. 31, 1885 ..	Domestic ports ..	16,321	112,126	128,447	277,789
	Consumed.......	5,000	30,000	35,000	
	Foreign ports....	153,443	5,926	159,369	
Jan. 1, 1886, to Dec. 31, 1886 ...	Domestic ports ..	14,622	187,558	202,180	430,549
	Consumed.......	9,000	60,000	69,000	
	Foreign ports....	189,995	9,740	199,735	
Jan. 1, 1887, to Dec. 31, 1887 ...	Domestic ports ..	15,905	181,918	197,823	480,558
	Consumed.......	13,000	70,000	83,000	
	Foreign ports....	124,474	3,611	128,085	
Jan. 1, 1888, to Dec. 31, 1888 ...	Domestic ports ..	20,404	212,078	232,482	448,567
	Consumed.......	13,000	75,000	88,000	

Detailed statement of total foreign and coastwise shipments and total consumption of South Carolina rock since June 1, 1874—Continued.

[Long tons.]

Period.	Shipments and consumption.	Beaufort.	Charleston.	Total.	Total for each year.
Jan. 1, 1889, to Dec. 31, 1889	Foreign ports	137,102	5,900	143,002	541,645
	Domestic ports	60,000	248,643	308,643	
	Consumed	15,000	75,000	90,000	
Jan. 1, 1890, to Dec. 31, 1890	Foreign ports	72,241	55,000	127,241	463,998
	Domestic ports	15,000	213,757	228,757	
	Consumed	13,000	85,000	98,000	
Jan. 1, 1891, to Dec. 31, 1891	Foreign ports	94,528	4,655	99,183	475,516
	Domestic ports	22,000	252,083	274,083	
	Consumed	14,000	88,250	102,250	
Jan. 1, 1892, to Dec. 31, 1892	Foreign ports	105,150	5,052	110,202	394,227
	Domestic ports	30,425	148,600	179,025	
	Consumed	15,000	90,000	105,000	
Jan. 1, 1893, to Dec. 31, 1893	Foreign ports	156,257	175	156,432	502,564
	Domestic ports	22,872	160,942	183,814	
	Consumed	15,000	147,318	162,318	
Jan. 1, 1894, to Dec 31, 1894	Foreign ports	114,155	12,417	126,572	450,108
	Domestic ports	21,000	154,853	175,853	
	Consumed	12,683	135,000	147,683	
Jan. 1, 1895, to Dec. 31, 1895	Foreign ports	114,430	10,090	124,520	431,975
	Domestic ports	9,500	155,855	165,355	
	Consumed	12,100	130,000	142,100	
Jan. 1, 1896, to Dec. 31, 1896	Foreign ports	80,960	1,290	82,250	402,423
	Domestic ports	44,391	140,782	185,173	
	Consumed	10,000	125,000	135,000	
Jan. 1, 1897, to Dec. 31, 1897	Foreign ports	65,828	....	65,828	358,280
	Domestic ports	11,072	143,211	154,283	
	Consumed	14,000	124,169	138,169	
Jan. 1, 1898, to Dec. 31, 1898	Foreign ports	60,925	....	60,925	399,884
	Domestic ports	25,349	148,610	173,959	
	Consumed	15,000	150,000	165,000	
Jan. 1, 1899, to Dec. 31, 1899	Foreign ports	96,323	2,305	98,628	356,650
	Domestic ports	21,378	90,422	111,800	
	Consumed	15,000	*a* 131,222	*a* 146,222	

a Includes 119,296 tons shipped by rail to fertilizer factories near Charleston.

In the following tables are shown the shipments of phosphate rock from Charleston and Beaufort, South Carolina, during 1899, by months, as compiled by the American Fertilizer. It will be observed that all the shipments recorded from Charleston are to domestic ports. The foreign shipments from Charleston have practically ceased. According to the reports of the Bureau of Statistics of the Treasury Department there were no exports of rock from Charleston either in 1897 nor 1898, and only a small amount (2,305 long tons) was shipped to foreign ports in 1899. On the other hand, nearly all of the rock shipped from Beaufort is to foreign markets. Out of a total of 103,048 long tons only 9,315 tons went to domestic ports. Charleston shipments consist of land rock and Beaufort shipments are river rock.

There is a slight difference between the foreign shipments from Beaufort as reported by the American Fertilizer and by the Bureau of

Statistics. The former gives the foreign shipments of river rock in 1899 at 93,733 long tons; the Bureau of Statistics reports 96,323 long tons as exported from Beaufort.

Shipments of phosphate rock from Charleston in 1899, by months.

[Long tons.]

Destination.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
Baltimore	4,193	6,088	1,436	952	4,716	4,277	1,679
Philadelphia	....	....	....	600	600	....	1,500
New York	600	685	1,303	....	....	....	730
Weymouth	....	900	....	....	955	....	....
Richmond, Va	3,354	....	....	674	1,060	2,100	2,300
Norfolk	....	2,100	....	....	750	513	....
Newtown Creek	600	....	....	....	611	600	....
Elizabethport, N. J.	960	....	....	2,947	776	....	....
Boston	....	950	803	1,825	1,765	....	....
Barren Island	....	....	....	650	....	....	612
Wilmington, N. C	....	....	....	1,207	....	....	511
Perryville, Ind	....	....	....	....	....	....	....
Cartaret, N. J	....	....	....	....	....	....	....
Southern R. R	1,696	303	1,696	968	1,139	441	210
Charleston and Savannah	9,292	8,278	10,863	11,596	9,409	7,440	9,687
Total	20,695	19,304	16,101	21,419	21,781	15,371	17,229

Destination.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Baltimore	5,758	3,834	575	2,460	3,025	38,993
Philadelphia	....	....	....	....	....	2,700
New York	751	922	....	760	....	5,751
Weymouth	....	....	4,958	....	....	6,813
Richmond, Va	....	....	2,200	....	2,000	17,051
Norfolk	....	....	....	....	....	
Newtown Creek	....	....	....	....	....	1,811
Elizabethport, N. J	....	731	1,576	....	....	6,990
Boston	....	....	....	....	....	5,343
Barren Island	....	....	....	....	750	2,012
Wilmington, N. C	....	....	....	....	....	1,718
Perryville, Ind	....	....	640	....	....	640
Cartaret, N. J	....	....	....	600	....	600
Southern R. R	374	690	951	539	412	9,419
Charleston and Savannah	7,841	6,560	8,537	10,367	10,007	109,877
Total	14,724	12,737	19,437	14,726	16,194	209,718

Shipments of phosphate rock from Beaufort, South Carolina, in 1899, by months.

[Long tons.]

Destination.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
Dublin	4,766				2,956	3,170	
Liverpool	2,002						
St. Nazaire	3,500						
London		1,722			3,406		
Cork			2,117				3,125
Garston			2,120		2,763		
Newcastle			2,578				
Baltimore			4,000		1,709	1,300	1,575
Cette				2,484			
Bristol				2,163			
La Palice				3,500			
Birkenhead				2,163	2,425		2,920
St. Louis du Rhone					3,862		
Fleetwood						1,674	
Savannah, Ga						621	
Honfleur							2,710
Kings Lynn							2,548
Belfast							
Hull							
Total	10,268	1,722	10,815	10,310	17,121	6,765	12,878

Destination.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Dublin				3,600	2,120	16,612
Liverpool						2,002
St. Nazaire					2,450	5,950
London	2,738					7,866
Cork						5,242
Garston		2,639				7,522
Newcastle						2,578
Baltimore						8,584
Cette						2,484
Bristol						2,163
La Palice	3,500					7,000
Birkenhead		3,580		5,948		17,036
St. Louis du Rhone						3,862
Fleetwood						1,674
Savannah, Ga	190					811
Honfleur						2,710
Kings Lynn						2,548
Belfast	4,000					4,000
Hull			2,404			2,404
Total	10,428	6,219	2,404	9,548	4,570	103,048

TENNESSEE.

The production of phosphate rock in Tennessee since the beginning of the industry in that State has been as follows:

Production of phosphate rock in Tennessee since 1894.

Year.	Quantity.	Value.
	Long tons.	
1894	19,188	$67,158
1895	38,515	82,160
1896	26,157	57,370
1897	128,723	193,115
1898	308,107	498,392
1899	424,109	1,177,166

The history of phosphate mining in Tennessee presents some features strikingly similar to that of Florida. The accidental discovery in Lewis and Hickman counties in 1893 by two timber buyers of what proved to be phosphate rock containing 70 per cent bone phosphate of lime was followed shortly afterwards by an influx of prospectors, promoters, speculators, and miners. A "boom" was on, and it was not long before Tennessee phosphate rock was being offered in large quantities at less than it cost to mine it, with disaster following in the wake of the boom. Other discoveries in Maury, Perry, Giles, Sumner, Williamson, and Davidson counties, while adding to the mineral resources of the State, did not improve the market conditions, and for three or four years the industry was in a very unsatisfactory condition. It was not until 1898 that the business began to get into satisfactory shape, and not until 1899 was there any apparent improvement in prices. On account of the distance of the Tennessee deposits from the seaboard, the rock must be of exceptionally high grade in order to stand the expense of freight necessary to reach foreign markets. The bulk of the rock mined in Tennessee is confined to domestic markets, and conservative action is necessary on the part of producers in order to maintain prices at profitable figures. Operators in the State claim, with excellent reason, that the industry has suffered much injury from exaggerated newspaper accounts of the "inexhaustible" nature of the deposits. Mr. H. D. Ruhm, in a contribution to the Tradesman, estimates the probable yield of the different fields as follows: Maury County (Mount Pleasant district), 15,000,000 tons; Sumner County, 2,500,000 tons; Perry County, 5,000,000 tons; Giles, Williamson, and Davidson counties, 7,500,000 tons. These estimates do not include the Hickman, Lewis, and western Maury County fields, whose product averages only 65 to 70 per cent bone phosphate.

The unsatisfactory condition of the Tennessee phosphate in the years preceding 1899 is exhibited in the tables of production. These show

that in 1897, when Tennessee produced 12 per cent of the total tonnage, the percentage of value credited to the State was 7½. In 1898 Tennessee's quota was 23½ per cent in tonnage and 15 per cent in value. In 1899 the tonnage of Tennessee was 30 per cent and the value 25 per cent of the total.

IMPORTS.

The following table shows the imports of fertilizers of all kinds into the United States from 1868 to 1899:

Fertilizers imported and entered for consumption in the United States, 1868 to 1899.

Year ending—	Guano.		Crude phosphates and other substances used for fertilizing purposes.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Long tons		*Long tons.*		
June 30, 1868	99,668	$1,336,761	....	$88,864	$1,425,625
1869	13,480	217,004	....	61,529	278,533
1870	47,747	1,414,872	....	90,817	1,505,689
1871	94,344	3,313,914	....	105,703	3,419,617
1872	15,279	423,322	....	83,342	506,664
1873	6,755	167,711	....	218,110	385,821
1874	10,767	261,085	....	243,467	504,552
1875	23,925	539,808	....	212,118	751,926
1876	19,384	710,135	....	164,849	874,984
1877	25,580	873,459	....	195,875	1,069,334
1878	23,122	849,607	....	285,089	1,134,696
1879	17,704	634,546	....	223,283	857,829
1880	8,619	108,733	....	317,068	425,801
1881	23,452	399,552	....	918,835	1,318,387
1882	46,999	854,463	133,956	1,437,442	2,291,905
1883	25,187	537,080	96,586	798,116	1,335,196
1884	28,090	588,033	35,119	406,233	994,266
1885	20,934	393,039	40,068	611,284	1,004,323
Dec. 31, 1886	13,520	306,584	82,608	1,179,724	1,486,308
1887	10,195	252,265	53,100	644,301	896,566
1888	7,381	125,112	36,405	329,013	454,125
1889	15,991	313,956	35,661	403,205	717,161
1890	4,642	59,580	31,191	252,787	312,367
1891	11,937	199,044	29,743	214,671	413,751
1892	3,073	46,014	92,476	666,061	712,075
1893	5,856	97,889	106,549	718,871	816,760
1894	5,757	105,991	126,820	904,247	1,010,238
1895	4,270	51,642	80,088	450,379	502,021
1896	6,532	79,815	113,955	639,858	719,673
1897	4,930	55,715	200,598	970,836	1,026,551
1898	4,482	50,783	139,472	720,053	770,836
1899	2,700	27,000	150,902	906,181	933,181

SULPHUR AND PYRITE.

By Edward W. Parker.

SULPHUR.

PRODUCTION.

The amount of sulphur produced in the United States forms a very small part of the amount consumed. During the past few years more than half of the sulphur consumed in this country has been obtained from iron pyrite, as is shown in a subsequent table. The domestic production in 1899, while still small, was more than 30 per cent larger than the combined output of 1897 and 1898, and exceeded the product in any other preceding year with the exception of 1896. Four States contributed to the product of 1899, which amounted to 4,830 short tons, valued at $107,500. The value of the domestic product in 1899 was the largest in our history.

The localities from which the product last year was obtained were: Calcasieu Parish, Louisiana; Humboldt County, Nevada; El Paso County, Texas, and Beaver County, Utah. The principal features of interest in 1899 were the resumption of operations at Sulphur City, Louisiana, the development work prosecuted on the deposits in El Paso County, Texas, and the reopening of the old mines in Humboldt County, Nevada. Nothing was done in the way of developing the deposits reported to exist in the vicinity of Beaumont, Texas.

Including the sulphur obtained from domestic and imported pyrites the domestic consumption amounts at present to about 350,000 long tons annually, from which it can be seen that our domestic production represents about 1 per cent of the market requirements.

The following table shows the annual production of sulphur in the United States since 1880:

Sulphur product of the United States since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	600	$21,000	1890	....	....
1881	600	21,000	1891	1,200	$39,600
1882	600	21,000	1892	2,688	80,640
1883	1,000	27,000	1893	1,200	42,000
1884	500	12,000	1894	500	20,000
1885	715	17,875	1895	1,800	42,000
1886	2,500	75,000	1896	5,260	87,200
1887	3,000	100,000	1897	2,275	45,590
1888	....	....	1898	1,200	32,960
1889	450	7,850	1899	4,830	107,500

DOMESTIC CONSUMPTION.

The use of iron pyrite for the manufacture of sulphuric acid has during the past decade grown to be an important industry, and in considering the production and consumption of sulphur the sulphur contents of pyrite used for acid making must necessarily be included. It is only since 1891, however, that accurate statistics in regard to the importations of pyrite for acid making have been available. Prior to 1884 pyrite was included among other sulphur ores in the statistics compiled by the Bureau of Statistics of the Treasury Department. Pyrite was separately reported from 1884 to 1887, but the small quantities reported indicate that a considerable amount was imported either under the former classification as sulphur ore or as iron ore under which it was classed from 1887 to 1891, when the copper contents did not exceed 3.5 per cent. Reviewing the industry then since 1891, it is seen that in that year the amount of sulphur produced in the United States was 1,071 long tons, and the imports 117,187 long tons, a total of 118,258 long tons. The domestic production of pyrite in the same year was 106,536 long tons, and the importations 100,648 long tons, a total of 207,184 tons. Estimating the sulphur contents of both domestic and imported pyrite at 45 per cent, this total represented 93,233 long tons of sulphur, and added to the sulphur consumption makes the total for the year 211,491 long tons. It will be seen in the following table that this total has shown a steady and almost uniform increase until 1898, during which period there were only two years in which the sulphur imports showed a decrease (the domestic production being inconsiderable and having little influence on the total), and in each case this decrease was more than compensated for in the increased consumption of iron pyrite. In no instance had there been

any decrease shown in the total pyrite consumption, any decline in domestic production being made up by larger imports, and vice versa. In 1898, notwithstanding the war between the United States and Spain, and sulphur contraband of war, the imports of sulphur into the United States showed an increase of 16 per cent. This was probably due to the increased demand for sulphur as one of the ingredients in powder manufacture, for which the sulphur contents of pyrite are not so readily available. The consumption of pyrite also showed an increase, all of which was made up of the domestic product, as there was a slight decrease in the imports. The total consumption in 1898 amounted to 366,337 long tons, of which 165,575 long tons were of sulphur and 200,762 long tons the sulphur contents of pyrite. The increase in the consumption of sulphur itself in 1898 as compared with 1891 was 47,316 long tons, or 40 per cent, while the amount of sulphur contained in iron pyrite consumed in 1898 was more than double that of 1891. The statistics for 1899 show that the imports of sulphur fell off approximately 23,000 long tons to 141,533 long tons, which was about the average amount imported in 1896 and 1897, indicating a lessened demand as a result of the close of the war with Spain. The production of iron pyrite in the United States also decreased, the sulphur contents of the product in 1899 (based upon 45 per cent sulphur) being 8,384 long tons less than that of the preceding year. This loss was nearly made up by an increase in the imports of iron pyrite, of which increase the sulphur contents were 7,693 long tons, 691 tons less than the decrease in the sulphur contents of domestic pyrite. The net decrease in the domestic consumption of sulphur from all sources in 1899 amounted to 20,433 long tons. It is the first time in eight years that the consumption has shown a decrease, and, as stated before, the decrease was probably due to the unusual demand in 1898.

The statistics of production, and imports of sulphur and the sulphur contents of domestic and imported pyrite exhibiting together the total domestic consumption, are presented in the following table:

Estimated consumption of sulphur in the United States from 1891 to 1899.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Sulphur:	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Domestic	1,071	2,400	1,071	446	1,607	4,696	2,031	1,071	4,300
Imported *a*	117,187	101,122	105,823	125,459	122,096	139,280	141,905	164,504	141,533
Sulphur contents of pyrite: *b*									
Domestic	47,941	49,405	34,100	47,673	44,697	51,968	64,440	87,014	78,630
Imported	45,292	68,561	87,715	74,596	85,796	90,076	116,796	113,748	121,441
Total domestic consumption	211,491	221,488	228,709	248,174	254,196	286,020	325,172	366,337	345,904

a Includes crude sulphur, flowers of sulphur, refined sulphur, and sulphur lac.
b Based on average sulphur contents of 45 per cent.

In the foregoing table the domestic production of sulphur has been reduced from short tons to long tons for the sake of uniformity.

THE SICILIAN SULPHUR INDUSTRY.

The island of Sicily, off the southern coast of Italy, furnishes the greater part of the world's supply of sulphur. For the past three years the industry has been largely controlled by the Anglo-Sicilian Sulphur Company, Limited, whose operations cover at least 70 per cent of the output. The syndicate has been able to keep the business fairly well in hand notwithstanding the rather unsatisfactory methods pursued by the independent producers, whose chief aim seems to be to get out all the sulphur possible without reference to the condition of the market or the immediate demand. According to a British consular report, the laws and provisions of the mining leases are chiefly responsible for the unsatisfactory conditions. A lease is usually made for ten years, during which time the leaseholder expects, and is expected by the landowner, to push the production as rapidly as possible and to pay his landlord 20 per cent royalty. At the end of the ten-year lease the landlord takes back the mine. In spite of having to contend with these conditions the operations of the syndicate appear to have been conducted satisfactorily, not only to the producers and refiners at Catania, but to the stockholders in dividends.

It is reported that during 1899 production was in excess of the market requirements to such an extent that the surplus carried over at the end of the year exceeded the stocks carried a year before by 100,000 tons. Much of this was doubtless due to the curtailed demand from the United States. This country takes about 30 per cent of the annual shipments, and any marked falling off in the demand from the United States is quickly felt at the producing point. The requirements of the paper manufacturers, who now consume large quantities of sulphur, will probably continue to increase.

PRICES OF SICILIAN SULPHUR.

Mr. Alfred S. Malcomson has furnished the Survey with the following statement of the prices of Sicilian sulphur, best unmixed seconds, ex steamer at New York, for each month during 1896, 1897, 1898, and 1899. The wide variation between the extremes of prices in April and May, 1898, was due to the war with Spain. In each case the lower figure was for sulphur sold previously for April and May delivery. The higher prices were for spot sulphur after hostilities began and before the syndicate could make arrangements for shipping:

Spot prices for Sicilian sulphur, per long ton, ex steamer at New York.

Date.	1896.	1897.	1898.	1899.
January	$15.50	$20.00 @ $20.50	$20.50	$21.00 @ $21.25
February	15.50	19.75	20.50	21.00
March	15.00	20.00	21.50	22.00 @ 22.50
April	15.50	19.25 @ 19.50	$21.50 @ 35.00	21.00
May	$15.50 @ 16.00	19.25 @ 19.50	21.75 @ 32.00	20.50 @ 21.00
June	19.00	19.25	24.00	20.75 @ 21.00
July	19.50	19.75	22.00	20.50
August	20.00 @ 21.00	20.00	21.00	20.50
September	22.50 @ 23.00	21.00	20.50 @ 21.00	20.50
October	24.00 @ 25.00	21.00	21.00 @ 22.00	21.00
November	22.00	21.00	21.00 @ 21.50	21.00
December	21.00	20.75	21.00	21.25

PRODUCTION OF SULPHUR IN ITALY.

In the following table the statistics of the amount and value of the sulphur produced in Italy since 1860 (practically all of which is from the island of Sicily) are taken from the official report Rivista del Servizio Minerario for all the years except 1898 and 1899, which are estimated. The estimates are based on the shipments and the average local consumption.

Production of sulphur in Italy from 1860 to 1899, inclusive.

Year.	Production.	Value.	Year.	Production.	Value.
	Long tons.			*Long tons.*	
1860	155,067	$3,693,036	1880	353,883	$7,037,859
1861	163,217	3,865,950	1881	367,163	8,088,237
1862	162,825	3,872,376	1882	438,751	9,002,010
1863	179,637	4,273,992	1883	439,332	8,181,887
1864	177,707	4,134,870	1884	404,431	7,048,751
1865	168,829	3,756,507	1885	418,708	6,748,077
1866	195,019	4,579,547	1886	368,327	5,396,720
1867	195,873	4,641,046	1887	336,715	4,572,979
1868	198,097	4,822,158	1888	370,486	4,827,512
1869	197,493	5,071,715	1889	365,524	4,758,005
1870	200,597	4,702,716	1890	363,305	5,455,201
1871	196,518	4,869,515	1891	389,171	8,593,413
1872	235,323	5,746,251	1892	411,828	7,569,781
1873	269,794	6,566,050	1893	410,958	5,716,018
1874	247,221	6,813,675	1894	399,260	4,876,715
1875	204,086	5,562,575	1895	364,807	3,989,877
1876	271,605	6,372,385	1896	419,501	5,919,554
1877	256,141	5,184,313	1897	488,676	8,680,800
1878	300,238	5,896,665	1898	a 525,000	9,300,000
1879	370,268	7,040,165	1899	a 550,000	9,735,000

a Estimated on the basis of shipments and stocks. Domestic consumption is taken at the average for the previous five years.

EXPORTS OF SICILIAN SULPHUR.

Taken in connection with the foregoing statistics, the following table exhibiting the exports of sulphur from Sicily, together with the countries to which exported since 1883, is of interest. It will be observed that during the entire period the United States has been the most important customer. The decrease in shipments to Great Britain since 1890 as compared with the earlier years has been due, doubtless, to the supply furnished by the recovery of sulphur from alkali waste. This table is compiled from the annual statements published by Mr. Alfred S. Malcomson, of New York. The shipments of 12,692 long tons to Canada in 1898 included in the total to the United States, and the statement on a subsequent page that the United States imported 10,437 long tons from Canada indicate that this product came through some Canadian port in transit.

Total exports of sulphur from Sicily since 1883.

Country.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
United States	96,629	94,929	99,378	98,590	89,419	128,265	109,008	106,656
France	63,602	65,098	58,264	54,280	56,222	52,083	67,340	71,790
Italy	66,810	56,292	49,415	48,658	48,997	47,664	43,523	40,231
United Kingdom	41,788	40,760	33,402	30,236	30,007	35,634	39,203	26,213
Greece	10,494	7,033	13,664	19,697	18,370	5,809	10,158	18,103
Portugal	15,298	11,018	17,760	30,943	16,587	15,851	16,799	16,695
Russia	10,413	12,831	13,420	10,570	13,441	22,043	17,678	17,158
Germany	7,232	6,622	6,103	8,689	9,700	12,402	15,401	15,703
Austria	4,915	6,037	5,965	5,800	6,702	8,942	8,984	8,746
Turkey	3,043	1,285	3,077	4,598	6,238	1,457	2,231	4,231
Spain	5,242	3,920	2,243	5,890	5,873	3,433	6,586	5,679
Belgium	7,660	6,793	9,516	6,580	5,318	6,951	7,752	7,279
Holland	1,256	696	1,237	2,999	1,747	2,793	2,424	....
Sweden	1,010	744	328	1,916	1,169	3,004	3,899	3,314
South America	....	....	....	....	710	95	23	....
Australia	....	....	....	....	600	885	....	400
Denmark	....	....	810	....	202	464	443	2,565
Total	335,392	314,058	314,582	329,446	311,302	347,775	351,451	344,763

Total exports of sulphur from Sicily since 1883—Continued.

Country.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
United States	97,520	84,450	83,901	105,773	99,227	124,923	118,137	138,435	128,441
France	56,168	73,176	89,736	56,932	69,696	76,739	84,895	88,657	96,043
Italy	42,212	38,711	54,486	49,895	49,349	54,009	73,052	62,652	87,230
United Kingdom	23,408	24,853	27,453	22,165	24,043	21,913	24,520	26,983	25,038
Greece and Turkey	11,414	*a*14,845	*a*13,840	*a*16,870	*a*16,195	*a*18,556	*a*13,866	*a*24,808	18,656
Portugal	11,439	13,490	14,545	8,670	14,562	12,001	7,054	8,257	12,269
Russia	11,930	14,178	19,730	17,977	17,962	18,752	17,532	12,285	19,211
Germany	10,629	14,326	16,259	16,437	15,472	15,680	19,721	27,048	25,933
Austria	10,575	9,096	10,169	11,494	12,170	13,799	15,993	15,796	18,519
Turkey	3,000	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Spain	3,845	7,382	3,499	3,445	5,753	5,910	4,039	3,233	7,757
Belgium	5,089	5,133	4,358	5,644	6,410	7,527	9,253	8,402	7,481
Holland	....	2,183	2,957	2,365	3,335	3,834	3,599	5,646	6,408
Sweden	2,252	4,561	6,579	7,887	5,730	14,540	11,226	12,331	12,476
Australia	....	1,200	....	....	....	....	....	....	....
Denmark	300	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)
Other countries	3,542	3,152	1,680	3,376	7,732	8,562	7,651	12,791	13,569
Total	293,323	309,536	349,192	328,930	347,636	396,745	410,538	447,324	479,031

a Exports to Greece and Turkey combined after 1892. *b* Included in exports to Sweden.

PORTS IN UNITED STATES RECEIVING SICILIAN SULPHUR.

The ports in the United States to which such shipments were made, together with the amount shipped to each since 1883, and the quality of the shipments since 1886, are shown in the following tables:

Ports in the United States receiving Sicilian sulphur and the amount received by each.

Port.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	41,238	46,460	50,814	49,952	45,979	60,706	55,939	37,390
Charleston	5,425	7,706	12,416	10,556	14,324	22,496	12,399	27,563
Philadelphia	23,123	19,234	12,153	15,662	11,764	11,793	14,334	11,094
Baltimore	16,175	13,986	16,435	15,680	10,306	17,330	15,316	16,700
Boston	5,864	4,723	4,200	3,800	3,300	6,300	4,950	2,500
Wilmington, N. C	....	....	....	....	1,020	2,355	2,040	1,309
Savannah	....	....	....	....	....	3,545	3,240	5,920
Pensacola	....	....	....	....	....	....	....	1,390
Port Royal	600	610	680	660	1,000	600	....	600
Providence	650	1,140	1,370	1,180	630	1,250	590	650
San Francisco	1,884	500	....	....	296	....	....	....
New Orleans	350	100	250	....	200	250	200	800
Woods Hole	650	470	1,060	1,100	....	1,160	....	....
Mobile	....	....	....	....	....	....	....	740
Other ports	670	....	....	....	600	480	....	....
Total	96,629	94,929	99,378	98,590	89,419	128,265	109,008	106,656

Ports of the United States receiving Sicilian sulphur, etc.—Continued.

Port.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	49,023	49,090	43,396	46,875	55,863	68,353	70,474	72,089	83,396
Charleston	21,646	4,510	13,525	15,296	9,150	7,700	5,130	2,100	....
Philadelphia	6,856	10,400	8,160	5,400	8,350	6,000	5,409	6,600	10,740
Baltimore	11,365	12,355	9,950	15,300	9,720	14,150	13,831	14,365	12,400
Boston	1,950	3,325	500	4,317	4,950	5,300	8,220	6,050	1,600
Wilmington, N. C.	2,600	....	1,140	1,890	650	2,660	1,550	1,700	....
Savannah	1,550	1,170	5,330	9,795	4,584	9,395	4,700	1,980	....
Pensacola	....	....	....	....	....	....	....	....	....
Port Royal	700	....	....	800	....	660	....	....	....
Providence	....	....	....	1,500	1,380	....	....	....	....
San Francisco	....	....	....	....	....	3,125	....	2,539	....
New Orleans	1,200	2,000	1,900	2,400	1,700	2,100	3,340	2,500	800
Mobile	....	....	....	800	880	....	....	....	....
Delaware Breakwater	630	....	....	....	....	....	....	....	....
Portland, Me	....	2,000	....	....	1,300	2,550	4,343	13,750	18,915
Norfolk	....	....	....	1,400	700	2,930	1,140	....	....
Portland, Ohio	....	....	....	....	....	....	....	2,070	....
Canada	....	....	....	....	....	....	....	12,692	....
Other ports	....	....	....	....	....	....	....	....	590
Total	97,520	84,850	83,901	105,773	99,227	124,923	118,137	138,435	128,441

Quality of Sicilian sulphur received at the different ports of the United States since 1886.

Port.	1886.		1887.		1888.		1889.	
	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	36,352	13,600	29,919	16,060	35,573	25,133	32,983	22,956
Charleston	7,506	3,050	8,875	5,449	15,485	7,011	6,325	6,074
Philadelphia	4,660	11,002	2,127	9,637	3,050	8,743	2,000	12,334
Baltimore	7,325	8,355	4,463	5,843	11,380	5,950	7,656	7,660
Boston	600	3,200	200	3,100	700	5,600	750	4,200
Savannah	....	....	....	....	2,130	1,415	2,790	1,450
Wilmington, N. C	....	....	1,020	....	2,355	....	2,040	....
Other ports	1,180	1,760	106	2,620	1,500	2,240	200	590
Total	57,623	40,967	46,710	42,709	72,173	56,092	53,744	55,264

Quality of Sicilian sulphur received at the different ports of the United States since 1886—Continued.

Port.	1890.		1891.		1892.		1893.		1894.	
	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	20,801	16,589	29,358	19,665	34,390	14,700	29,146	14,250	33,150	13,725
Charleston	20,873	6,690	17,196	4,450	4,010	500	11,665	1,860	3,273	12,023
Philadelphia	1,000	10,094	450	6,406	3,600	6,800	1,900	6,260	350	5,050
Baltimore	5,930	10,770	4,510	6,855	900	11,455	2,050	7,900	600	14,700
Boston	200	2,300	1,300	650	1,825	1,500	500	....	1,017	3,300
Savannah	2,750	3,170	850	700	600	570	3,450	1,880	5,695	4,100
Wilmington, N. C.	1,309	....	1,900	700	....	....	....	1,140	....	1,890
New Orleans	....	....	....	....	....	....	1,900	....	2,400	....
Other ports	1,540	2,640	1,200	1,330	4,000	....	....	....	800	3,700
Total	54,403	52,253	56,764	40,756	49,325	35,525	50,611	33,290	47,285	58,488

Port.	1895.		1896.		1897.		1898.		1899.	
	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	35,888	19,975	50,557	17,796	57,174	13,300	49,614	22,475	56,746	26,650
Charleston	700	8,450	2,330	5,370	1,500	3,630	500	1,600	....	....
Philadelphia	1,200	7,150	500	5,500	199	5,210	1,200	5,400	2,740	8,000
Baltimore	1,100	8,620	3,650	10,500	3,798	10,033	2,350	12,015	3,800	8,600
Boston	2,350	2,600	4,600	700	7,220	1,000	4,500	1,550	600	1,000
Savannah	3,784	800	8,370	1,025	4,700	....	1,980	....	....	....
Wilmington, N. C.	....	650	1,260	1,400	....	1,550	500	1,200	....	....
New Orleans	1,700	....	2,100	....	3,340	....	500	2,000	....	800
Portland, Me	1,300	....	2,550	....	4,343	....	13,750	....	18,915	....
Other ports	580	2,380	5,425	1,290	540	600	14,101	3,200	590	....
Total	48,602	50,625	81,342	43,381	82,814	35,323	88,995	49,440	83,391	45,050

REDUCTION OF SULPHUR ORE IN SICILY.

In response to a request from the State Department, the United States consuls at Catania and Palermo have furnished the following descriptions of the methods in vogue in and near those cities for the reduction of sulphur ore:

CATANIA.

There are four different methods employed in Catania for the fusion of sulphur ore, known, respectively, as the calcarone, Gill, Fiocchi, and Orlando systems.

The first, the calcarone, is the primitive mode of extraction, and is the one generally used. The kiln is built into the ground to a depth

of 6 to 9 feet, the walls being of masonry and cylindrical in form, with a sloping floor of stone and gypsum. When the calcarone, or kiln, is filled, the ore at the bottom is in large pieces, so that there may be no impediment to the "olid" (Sicilian term for molten sulphur) running out, and the pieces of ore become gradually smaller until the top of the calcarone is reached. The ore is then heaped up in the form of a large cone, and is covered with turf, sand, and refuse from former fusions, to prevent loss and to protect it somewhat from the elements. During the filling process several air shafts are placed in the ore, by means of which the fire is communicated thereto, and through combustion of the mineral itself the whole mass melts, this process lasting from ten to twenty days. A small hole is made at the lowest point of the wall, through which the liquefied sulphur runs and is taken off into square wooden forms, containing from 130 to 170 pounds of sulphur. This is continued day by day until all the sulphur is extracted. The capacity of the kilns varies from 7,000 to 52,500 cubic feet, and one fusion of a large calcarone lasts three months. One great disadvantage of this system is the danger to vegetation by sulphur fumes. The calcarone is allowed by law to be in operation only from June 28 to December 31.

The second system, known as the "Gill," is by furnaces or ovens built in masonry similar in form to the calcarone, but much smaller and covered with a cupola of masonry. They are generally built and worked in pairs, and each cell or oven contains from 5 to 30 cubic meters (177 to 1,059 cubic feet) of ore. They are, however, also built in batteries of four, and the system is this: After being charged the ore in one cell is fired and the smoke, instead of passing into the open air, as is the case with the calcarone, passes into the adjacent cell and gradually heats the mineral, until by the time the first cell has finished working, the other has reached such a temperature that the ore ignites and cell No. 1 is again filled; and so the process goes on. The advantage is that the gases, which are heavily charged with sulphur, are not lost, and the percentage of sulphur recovered is considerably higher; further, the time occupied is much less than with the calcarone, the working of each cell occupying from seventy-two to ninety-six hours, according to size, and as very little smoke escapes, the proprietors can work all through the year.

The next system, known as the "Fiocchi" patent, consists of wrought-iron cylindrical receptacles, which are suspended by circular flanges and have an inner perforated shell. When the apparatus is ready to be filled with ore it is placed in a vertical position, and the ore, before being put in, is broken into small pieces; when filled, the apparatus is turned in a horizontal position and a steam pipe is screwed on. Steam at from 60 to 80 pounds pressure is then turned on, pass-

ing into the space between the outer and inner shell and to the mineral through the perforations of the inner shell, and in this way reaching all parts of the ore. As the mass of ore is heated the steam becomes dry and the sulphur fuses and is run off into proper receptacles.

The apparatus is 4 meters long by 1.20 meters in diameter. Three are worked in a row, each containing 3 cubic meters of ore, and seven fusions are made in twenty-four hours. A steam boiler of 16 horse-power is required for the necessary steam. This system is adapted for rich ore or ore that is porous; very hard ore can not be fused. The percentage of sulphur recovered is much greater than with the calcarone method, with the added advantage that the sulphur ore can be rapidly turned into commercial sulphur. The cost of a plant of this kind being rather heavy, the smaller mine owners prefer the old calcarone system.

The last is the Orlando system, and is the same as the Fiocchi, except that the apparatus always remains horizontal. Four trains, each loaded with about 15 hundredweight of ore, are run in on rails and remain during the fusion. The advantage over the Fiocchi system is the greater facility in charging and discharging the apparatus.

All the refining of sulphur, with the exception of one plant at Palermo, is done at Catania. The largest plant consists of four ovens, each containing a battery of ten retorts for refining, capable of turning out 48 tons of refined sulphur in twenty-four hours; four ovens with four chambers for subliming and making flowers of sulphur, capable of producing 2,000 tons during a season, and a steam mill with runner edge stones of lava, capable of milling 3,000 half-hundredweight bags (165,000 pounds) of sulphur a day.

The refining season commences in October and ends in June. The milling season lasts only about four months—say from February to June—and the product is used almost exclusively for the sulphuring of vines. In refining sulphur a large oven in masonry is used, with an arched roof, upon which are placed the cast-iron retorts, which are again covered by another arch, upon which are placed cast-iron boxes surrounded by brickwork. Newcastle coal, mixed with wood in order to obtain an abundance of flame, is used. The fire grate is at the bottom of the oven, and the gases and flame ascend by spiral openings and play around the retorts, and the smoke rises by the flues to the cast-iron boxes and thence to the chimney or stack. The sulphur is put into the cast-iron boxes, where it is fused, and by means of a valve it passes into the retorts, where it is transformed into gas, and from there, by a special cast-iron pipe, it passes into the condensers, which are cylindrical cast-iron vessels. The refined sulphur, which has again become liquid, then passes by a special aperture into cast-iron pans, so that it may gain the required temperature, and is then ladled out into cast-iron forms of about 1 hundredweight (110 pounds) capacity;

or, if rolled sulphur is required, it is ladled into metallic molds of the shape usually employed in commerce.

In subliming sulphur an oven, as described above for refining, is used, but with only two retorts, and the gases, instead of going into the condensers, ascend into a large, specially constructed chamber, lined with bricks, which is hermetically closed with the exception of a valve in the roof, which opens automatically when the tension produced by the gases is too great for the strength of the chamber. The gases, as they enter the chamber at the necessary temperature, solidify, and the sublimed sulphur falls in the form of flakes, like snow, to the ground.

The sulphur of commerce contains from 2 to 5 per cent of impurities. The lower, dark-colored qualities—such as good or current thirds—are generally used for refining, owing to their lower price.

The total export of sulphur from Catania from January 1 to December 1, 1898, was 415,424 tons, of which the United States received 131,678 tons; France, 84,369 tons, and Germany, 26,727.

PALERMO.

There are at the present time three methods of reducing sulphur ore in this district, viz, the calcinatory furnace ("calcarone"), the Gill oven, and the steam process.

By the first two methods the fuel used is sulphur in its mineral state, and by the third pit coal. Reduction by calcinatory furnace is the more general method in use, as the furnace is easy of construction and involves little expense, being operated in the open air and capable of smelting several thousands of tons of ore at a time.

The calcarone is located as near the mouth of the shaft or mine as possible, usually on the side of a hill, so that, when the process of smelting is complete, the sulphur may run down the hill in channels prepared for that purpose, part of the sulphur being burned in the process of smelting, in order to liquefy the remainder.

The calcarone is circular in shape, and has a floor with an inclination of from 12 to 18 degrees. The wall around it is made of rough stone cemented with a mortar of gypsum. At the back of the wall the thickness is some 45 centimeters, increasing to the front, where it is 1 meter or more, according to the diameter.

In the front is an opening, 1.30 meters high by some 30 centimeters broad (51 by 12 inches), through which the melted sulphur flows. Two walls run at right angles with the circular wall upon each side of this opening, 80 centimeters in thickness, with a roof over them to strengthen the front of the kiln. The stone floor of the kiln is covered with the refuse of a former smelting, called "ginese." The stonework is from 15 to 25 centimeters (6 to 9.3 inches) in thickness, and the covering of ginese is some 20 centimeters in depth, this increasing

at the lower extremity. The inner side of the wall is covered with a mortar of gypsum. The capacity of these calcarones varies from 100 to 1,000 tons. It requires thirty days to run off a calcarone of a capacity of 300 tons; sixty days for a capacity of 1,000 tons.

The cost of a calcarone with a capacity of 1,000 tons is 1,500 lire, or about $300 in United States currency.

In filling the calcarone the larger blocks of ore are placed in the center, forming, as it were, the backbone of the pile, the remaining space being filled with ore much smaller in size. When the calcarone is filled with ore and covered with ginese, the shape or form of the pile is that of a cone, and after being set on fire it resembles a small volcano. As the liquid sulphur comes from the calcarone, it flows into wooden molds, forming solid blocks, weighing about 100 pounds each.

The quantity of sulphur produced by this system during the years 1890, 1891, 1892, 1893, and 1894, compared with the total production of the mines operated, shows the following proportions: 80 per cent, 71 per cent, 65 per cent, 66 per cent, and 62 per cent, respectively.

At the present time about 20 per cent of the total production of sulphur in Sicily is reduced by the "Gill" system. Originally this system consisted of but two rooms or cells, but at the present time four cells are built together. These have usually from 10 to 50 cubic meters capacity. While the percentage of sulphur obtained by this system is greater than by the calcinatory furnace, the quality is said to be inferior. These ovens being built of solid stone masonry, it is claimed that much heat is saved and again utilized by this system of reduction. One cell only being fired at a time, the ore in the others becomes dried out, and is in a much better condition to burn freely when fired, thus saving both time and fuel. The floors of these cells are constructed upon the same principle and of the same material as those of the calcinatory furnace.

Reduction of sulphur ore by steam covers only about 10 per cent of the production of the mines in Sicily. The boilers or "cookers" in use are of various kinds and forms, some being movable, while others are stationary. In those of a cylindrical shape the ore is placed in a capsule of perforated iron plate inside the boiler. By the more general method the ore is reduced in small wagons having perforated bottoms and sides, the steam being conducted through iron pipes. Only a certain quality of the sulphur ore of Sicily—a very small percentage of the production—yields to steam process, and for this reason it is not probable that the reduction of sulphur by steam, as at present utilized, will become general.

By the calcinatory furnace and the Gill system, the fuel used being the crude sulphur, the cost is trifling, while fuel for steam reduction has to be shipped into the country at a great expense.

The system of reduction by the calcinatory furnace is the oldest known to the sulphur producer of Sicily. It is said to have been the original method employed at these mines centuries ago. Being simple in construction, furnishing its own fuel, and requiring little skill to operate, it bids fair to remain the favorite method.

IMPORTS.

The following statements, showing the amount and value of sulphur imported into the United States for a series of years, are obtained from the Bureau of Statistics of the Treasury Department:

Sulphur imported and entered for consumption in the United States, 1867 to 1899.

Year ending—	Crude.		Flowers of sulphur.		Refined.		All other. *a*		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Long tons.*		*Long tons.*		*Long tons.*		
June 30, 1867...	24,544	$620,373	110	$5,509	251	$10,915	....	....	$636,797
1868...	18,151	446,547	16	948	65	2,721	....	....	450,216
1869...	23,590	678,642	97	4,576	645	27,149	....	....	710,367
1870...	27,380	819,408	76	3,927	157	6,528	....	$1,269	831,132
1871...	36,131	1,212,448	66	3,514	92	4,328	....	754	1,221,044
1872...	25,380	764,798	36	1,822	57	2,492	....	....	769,112
1873...	45,533	1,301,000	55	2,924	36	1,497	....	....	1,305,421
1874...	40,990	1,260,491	51	2,694	57	2,403	....	....	1,265,588
1875...	39,683	1,259,472	18	891	....	....	....	....	1,260,363
1876...	46,435	1,475,250	41	2,114	44	1,927	....	....	1,479,291
1877...	42,963	1,242,888	116	5,873	1,171	36,962	....	....	1,285,723
1878...	48,102	1,179,769	159	7,628	150	5,935	....	....	1,193,332
1879...	70,370	1,575,533	138	6,509	69	2,392	....	....	1,584,434
1880...	87,837	2,024,121	124	5,516	158	5,262	....	....	2,034,899
1881...	105,097	2,713,485	98	4,226	71	2,555	....	....	2,720,266
1882...	97,504	2,627,402	159	6,926	59	2,196	....	....	2,636,524
1883...	94,540	2,288,946	79	3,262	115	4,487	....	....	2,296,695
1884...	105,112	2,242,697	178	7,869	126	4,765	....	....	2,255,331
1885...	96,839	1,941,943	121	5,351	114	4,060	....	....	1,951,354
1886...	117,538	2,237,989	213	8,739	116	3,877	....	....	2,250,605
1887...	96,882	1,688,360	279	9,980	84	2,383	....	....	1,700,723
Dec. 31, 1888...	98,252	1,581,583	128	4,202	27	734	....	....	1,586,519
1889...	135,933	2,068,208	15	1,954	10	299	....	....	2,070,461
1890...	162,674	2,762,953	12	1,718	103	3,060	....	....	2,767,731
1891...	116,971	2,675,192	206	6,782	10	1,997	....	....	2,683,971
1892...	100,938	2,189,481	158	5,439	26	4,106	....	....	2,199,026
1893...	105,539	1,903,198	241	5,746	43	1,017	....	....	1,909,961
1894...	125,241	1,703,265	173	4,145	45	1,207	....	....	1,708,617
1895...	121,286	1,546,481	581	12,888	229	4,379	....	50,006	1,613,754
1896...	138,168	1,967,454	665	13,266	447	8,226	....	183,683	2,172,569
1897...	136,563	2,395,436	....	....	....	....	5,342	58,637	2,454,073
1898...	151,225	2,891,767	507	14,548	163	4,396	12,609	159,213	3,069,924
1899...	140,182	2,484,801	335	9,917	184	4,519	832	23,966	2,523,203

a Includes sulphur lac and other grades not otherwise provided for, but not pyrite

Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each fiscal year from 1896 to 1899.

Countries whence exported and customs districts through which imported.	1896.		1897.	
	Quantity.	Value.	Quantity.	Value.
COUNTRY.	*Long tons.*		*Long tons.*	
England	15,640	$248,498	10,298	$194,992
Italy	125,850	1,586,551	108,908	1,821,056
Japan	8,997	95,244	9,446	140,426
Other countries			1,481	27,133
Total	150,487	1,930,293	130,133	2,183,607
DISTRICT.				
Baltimore, Md	13,759	169,666	10,139	161,524
Beaufort, S. C	660	8,250		
Boston and Charlestown, Mass	19,564	304,374	14,088	259,559
Charleston, S. C	9,730	118,885	6,370	109,186
New Orleans, La	2,139	28,711	3,050	53,041
New York, N. Y	74,281	914,504	61,151	1,035,786
Norfolk and Portsmouth, Va	2,400	31,970	1,153	17,650
Philadelphia, Pa	9,085	122,195	6,726	111,725
Portland, Me	1,600	21,435	5,400	94,279
Providence, R. I	580	7,276		
Puget Sound, Wash	458	5,710	32	1,275
San Francisco, Cal	6,370	66,934	9,973	134,565
Savannah, Ga	7,764	102,905	7,295	129,747
Willamette, Oreg	47	720	2,696	42,020
Wilmington, N. C	2,050	26,758	2,060	33,250
Total	150,487	1,930,293	130,133	2,183,607

Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each fiscal year from 1896 to 1899—Continued.

Countries whence exported and customs districts through which imported.	1898.		1899.	
	Quantity.	Value.	Quantity.	Value.
COUNTRY.	*Long tons.*		*Long tons.*	
Canada	10,437	$265,969	5,098	$127,960
England	7,359	157,747	5,163	109,381
Italy	146,596	2,613,394	114,051	2,050,078
Japan	7,489	146,813	4,328	81,818
Other countries	508	9,605	43	1,212
Total	172,389	3,193,528	128,683	2,370,449
DISTRICT.				
Baltimore, Md	16,938	296,073	15,276	262,146
Boston and Charlestown, Mass	15,866	308,092	9,596	188,519
Champlain, N. Y	5,678	144,216	1,546	38,915
Charleston, S. C	7,230	123,871		
Mobile, Ala	299	9,256		
New Orleans, La	2,300	35,690	2,588	51,652
New York, N. Y	86,761	1,539,858	61,476	1,098,389
Norfolk and Portsmouth, Va	406	9,868		
Philadelphia, Pa	6,585	116,264	8,611	151,065
Portland, Me	10,100	191,065	16,450	309,948
San Francisco, Cal	6,338	121,050	5,371	99,767
Savannah, Ga	4,780	89,928		
Vermont, Vt	2,675	72,121	1,161	29,204
Willamette, Oreg	1,653	37,804	3,001	56,871
Wilmington, N. C	2,450	45,063		
All other	2,330	53,309	3,607	83,973
Total	172,389	3,193,528	128,683	2,370,449

PYRITE.

PRODUCTION.

As compared with 1898 the production of iron pyrite for acid making in the United States decreased about 9 per cent with a corresponding decrease in value. In 1898, sympathizing with the extraordinary demand for sulphur in that year, the production of pyrite increased over 50,000 long tons—to 193,364 long tons from 143,201 long tons in 1897. The product in 1899 dropped back to 174,734 long tons—a falling off of 18,130 long tons. The output in 1899, however, was 33,016 long tons larger than that of 1897, and, with the exception of 1898, the largest ever won. The increase of 33,016 tons from 1897 to 1899 would probably represent the normal increase under usual conditions, being somewhat less than the increase in production during 1897 over 1895.

The loss in domestic production in 1899 was made up almost ton for ton in the increase of imported material. The decrease in production was 18,630 tons, and the increase in imports 17,095 tons—a difference of only 1,535 tons. The amount of imported pyrite entering into consumption in 1899 was the largest on record.

Prices in 1899 showed a slight advance, the average value per ton for the domestic product in the past year being $3.11 as compared with $3.07 in 1898.

The actual amount of pyrite mined in the United States was 175,075 long tons, of which 174,734 tons were sent to market. The latter figure is considered the commercial product in this report. In 1898 the amount mined was 204,452 long tons, of which 193,364 tons was marketed, leaving about 11,000 tons carried over in stock, or of too low grade to be sold. The difference between the mined and the marketed product in 1899 was only 341 tons.

About 70 per cent of the pyrite product in 1898 was from Virginia, 22 per cent was from Massachusetts, and the other 8 per cent was contributed by California, Colorado, New York, North Carolina, Ohio, and Tennessee. In 1899 61 per cent of the product came from Virginia, 23 per cent from Massachusetts, and 16 per cent from California, Colorado, New York, North Carolina, and Ohio. Tennessee did not report any production in 1899, and as Virginia's quota fell from 70 per cent in 1898 to 61 per cent in 1899, the decrease in the latter year is distributed between these States.

The amount and value of pyrite mined for sulphur contents in the United States since 1882 have been as follows:

Production of pyrite in the United States from 1882 to 1899.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Long tons.			*Long tons.*	
1882	12,000	$72,000	1891	106,536	$338,880
1883	25,000	137,500	1892	109,788	305,191
1884	35,000	175,000	1893	75,777	256,552
1885	49,000	220,500	1894	105,940	363,134
1886	55,000	220,000	1895	99,549	322,845
1887	52,000	210,000	1896	115,483	320,163
1888	54,331	167,658	1897	143,201	391,541
1889	93,705	202,119	1898	193,364	593,801
1890	99,854	273,745	1899	174,734	543,249

IMPORTS.

The following table shows the imports of pyrite containing not more than 3.5 per cent of copper from 1884 to 1899:

Imports of pyrite containing not more than 3.5 per cent of copper from 1884 to 1899. (*a*)

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Long tons.			*Long tons.*	
1884	16,710	$50,632	1894	163,546	$590,905
1885	6,078	18,577	1895	190,435	673,812
1886	1,605	9,771	1896	200,168	648,396
1887	16,578	49,661	1897	259,546	747,419
1891	100,648	392,141	1898	252,773	717,813
1892	152,359	587,980	1899	269,868	1,077,061
1893	194,934	721,699			

a Previous to 1884, classed among sulphur ores; 1887 to 1891, classed among other iron ores; since 1891, includes iron pyrite containing 25 per cent and more of sulphur.

CONSUMPTION.

As the imports of iron pyrite for use in the manufacture of sulphuric acid were not stated separately by the Bureau of Statistics of the Treasury Department prior to 1891, a comparison with the preceding years can not be made. The following table shows the amount of pyrite mined and imported for the past five years, and as no exports are reported by the Treasury Department, these figures may be accepted as representing the domestic consumption. The table also shows the estimated amount of sulphur displaced each year, on a basis of 45 per cent of sulphur contents.

Amount of pyrite consumed in the United States, and estimated sulphur displaced, from 1891 to 1899.

Source.	1891.	1892.	1893.	1894.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Domestic product	106,536	109,788	75,777	105,940
Imports	100,648	152,359	194,934	163,546
Domestic consumption	207,184	262,147	270,711	269,486
Sulphur displaced, estimated on basis of 45 per cent contents	93,233	117,966	121,815	121,269

Source.	1895.	1896.	1897.	1898.	1899.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Domestic product	99,549	115,483	143,201	193,364	174,734
Imports	190,435	200,168	259,546	252,773	269,868
Domestic consumption	289,984	315,651	402,747	446,137	444,602
Sulphur displaced, estimated on basis of 45 per cent contents	130,493	142,097	181,236	200,672	200,071

CANADIAN PRODUCTION.

While the production and consumption of pyrite in the United States have been steadily increasing, production in Canada has been steadily declining for several years, the production in 1899 being less than half of what it was in 1891, and less than 40 per cent of the product in 1889. The output in 1899 was the smallest in fourteen years.

Since 1886 the production of pyrite in Canada has been as follows:

Annual production and value of pyrite in Canada since 1886.

Calendar year.	Tons of 2,000 lbs.	Value.	Calendar year.	Tons of 2,000 lbs.	Value.
1886	42,906	$193,077	1893	58,542	$175,626
1887	38,043	171,194	1894	40,527	121,581
1888	63,479	285,656	1895	34,198	102,594
1889	72,225	307,292	1896	33,715	101,155
1890	49,227	123,067	1897	38,910	116,730
1891	67,731	203,193	1898	32,218	128,872
1892	59,770	179,310	1899	27,687	110,748

WORLD'S CONSUMPTION.

The following table has been compiled, chiefly from official sources, to show the pyrite production in the principal producing countries, and to exhibit to what an extent pyrite has supplanted sulphur for acid making. In the case of Spain the exports are taken instead of the production for such years as they are available. The published figures of pyrite production in Spain show an output in each year averaging from 20 to 25 per cent of the exports. As the export figures are probably taken from the custom-house records they are considered more reliable.

World's product of iron pyrite, and amount of sulphur displaced.

Country.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Spain (*a*)	279,161	435,906	393,453	511,769	480,255	98,393	217,545	255,896
France	243,030	226,304	227,288	278,452	248,934	295,325	298,571	306,002
United States	106,536	109,788	75,777	105,940	99,549	115,483	143,201	193,364
Italy							57,383	66,120
Canada	60,474	53,372	52,270	36,185	30,534	30,103	34,471	24,721
United Kingdom							10,583	12,102
Total	689,211	1,005,370	748,788	932,346	859,272	539,304	761,754	858,205
Sulphur displaced (*b*)	310,145	452,416	336,955	419,556	386,672	242,687	342,789	386,192

a Exports except in 1896. *b* Based on estimated 45 per cent of sulphur contents.

GYPSUM.

By Edward W. Parker.

PRODUCTION.

The year 1899 was one of record-breaking activity in the production of gypsum and calcined plaster. The amount of the product was 67 per cent larger than that of 1898, which was the year of previous maximum production. The value exceeded that of 1898 by 70 per cent and that of 1895, the year of previous maximum value, by 61 per cent. The total product in 1899 was 486,235 short tons, against 291,638 short tons in 1898 and 288,982 short tons in 1897. The value of the output, taken for the material in its first marketable condition, was $1,287,080, against $755,280 in 1898 and $755,864 in 1897. The amount of crude plaster sold in 1899 was unusually large, and there was a decline in the average price obtained for land plaster. Under ordinary circumstances these would result in a comparative falling off in the total value, but they were more than offset by an increase of 50 per cent in the production of calcined plaster, or stucco. There was an advance of 13 per cent in the price per ton of calcined plaster in addition to the notable increase in product. The amount of calcined plaster (including wall plasters and the finer grades of plaster of paris) manufactured in 1899 was 286,227 short tons, against 190,083 short tons in 1898, an increase of 96,144 tons, or 50 per cent. The value of the calcined plaster increased $462,214, or 70 per cent, from $657,303 in 1898 to $1,119,521 in 1899. The production of land plaster increased 20 per cent, from 40,929 short tons in 1898 to 50,033 short tons in 1899. The value of the land plaster increased only 11 per cent, from $90,777 to $100,797, the average price showing a decline of 21 cents per ton, from $2.22 in 1898 to $2.01 in 1899.

There were 17 States and Territories which produced gypsum in 1899. Michigan holds first place among these, with a tonnage in 1899 equal to 34 per cent of the total gypsum product of the United States. Kansas holds second place, with Iowa third, Texas fourth, New York fifth, and Ohio sixth. These six States produce about 90 per cent of the total product. The other producing States and Territories are Arizona, California, Colorado, Montana, Oklahoma, Indian Territory,

Oregon, South Dakota, Utah, Virginia, and Wyoming. In the following tables it has been found necessary in some cases to combine the statistics of two or more States in order to protect individual reports. The details of production in 1898 and 1899, by States, were as follows:

Product of gypsum in the United States in 1898, by States.

State.	Total product.	Sold crude.		Ground into land plaster.		Calcined into plaster of paris.			Total value.
		Quantity.	Value.	Quantity.	Value.	Before calcining.	After calcining.	Value.	
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*	*Short tons.*		
California	3,800	215	$1,297	710	$4,600	2,875	2,220	$19,080	$24,977
Colorado and Wyoming	5,390	....	....	....	....	5,390	4,263	23,712	23,712
Iowa and Kansas	83,913	101	202	1,026	1,505	82,786	64,477	235,501	237,208
Michigan	93,181	1,984	1,984	13,345	20,493	77,852	63,005	181,833	204,310
New York	31,655	2,243	1,353	17,112	40,066	12,300	9,275	40,550	81,969
Virginia	8,378	320	676	6,258	17,464	1,800	1,447	5,248	23,388
Other States (*a*)	65,321	895	1,688	2,478	6,649	61,948	45,396	151,379	159,716
Total	291,638	5,758	7,200	40,929	90,777	244,951	190,083	657,303	755,280

a Includes the product of Arizona, 30 tons; Montana, 1,123 tons; Ohio, 21,303 tons; Oklahoma, 3,150 tons; Oregon, 150 tons; South Dakota, 2,740 tons, Texas, 34,215 tons, and Utah, 2,610 tons.

Product of gypsum in the United States in 1899, by States.

State.	Total product.	Sold crude.		Ground into land plaster.		Calcined into plaster of paris.			Total value.
		Quantity.	Value.	Quantity.	Value.	Before calcining.	After calcining.	Value.	
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*	*Short tons.*		
California	2,950	....	....	2,600	$10,700	350	250	$4,250	$14,950
Colorado and Wyoming	5,675	....	....	18	72	5,657	4,293	24,882	24,954
Iowa and Kansas	160,620	16,109	$16,147	4,175	7,336	140,336	106,272	520,427	543,910
Michigan	144,776	39,266	47,178	17,195	27,030	88,315	71,543	209,329	283,537
New York	52,149	1,900	1,677	13,924	25,290	36,325	26,443	78,566	105,533
Virginia	11,480	225	463	9,349	22,758	1,906	1,589	8,822	32,043
Other States (*a*)	108,585	852	1,297	2,772	7,611	104,961	75,837	273,245	282,153
Total	486,235	58,352	66,762	50,033	100,797	377,850	286,227	1,119,521	1,287,080

a Includes the product of Arizona, 47 tons; Indian Territory, 12,000 tons; Montana, 582 tons; Ohio, 27,205 tons; Oklahoma Territory, 11,526 tons; Oregon, 550 tons; South Dakota, 550 tons; Texas, 53,773 tons, and Utah, 2,352 tons.

The average prices for crude gypsum and for land plaster in 1899 were lower than in either 1897 or 1898, while the price of calcined plaster was a few cents higher in 1899 than in 1898, as shown in the following table:

Distribution of the gypsum product of the United States since 1889.

Year.	Total amount produced.	Sold crude.			Ground into land plaster.		
		Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
	Short tons.	*Short tons.*			*Short tons.*		
1889	267,769	73,243	$82,704	$1.13	108,771	$233,307	$2.14
1890	182,995	18,742	19,148	1.02	56,525	143,014	2.53
1891	208,126	18,574	28,690	1.54	51,700	117,356	2.27
1892	256,259	58,080	80,797	1.39	47,668	106,247	2.23
1893	253,615	42,808	71,860	1.68	50,408	106,365	2.11
1894	239 312	34,702	56,149	1.62	41,996	95,944	2.28
1895	265,503	26,624	37,837	1.42	35,079	85,355	2.43
1896	224,254	17,302	19,134	1.11	27,354	59,749	2.18
1897	288,982	23,164	27,020	1.17	31,562	67,083	2.13
1898	291,638	5,758	7,200	1.25	40,929	90,777	2.22
1899	486,235	58,352	66,762	1.14	50,033	100,797	2.01

Year.	Calcined into plaster of paris.				Total value.
	Weight before calcining.	Calcined plaster produced.	Value.	Average price per ton.	
	Short tons.	*Short tons.*			
1889	85,755	64,711	$448,107	$6.92	$764,118
1890	107,728	79,257	412,361	5.20	574,523
1891	137,852	110,006	482,005	4.38	628,051
1892	150,511	106,141	508,448	4.79	695,492
1893	160,399	122,937	518,390	4.22	696,615
1894	162,614	127,158	609,626	4.79	761,719
1895	203,800	150,801	674,255	4.47	797,447
1896	179,598	137,505	494,461	3.60	573,344
1897	234,256	180,935	661,761	3.66	755,864
1898	244,951	190,083	657,303	3.46	755,280
1899	377,850	286,227	1,119,521	3.91	1,287,080

The total production and value, by States, for the same period were as follows:

Comparative statistics of gypsum production for eleven years.

State.	1889.		1890.		1891.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Colorado	7,700	$28,940	4,580	$22,050	....	....
Iowa	21,784	55,250	20,900	47,350	31,385	$58,095
Kansas	17,332	94,235	20,250	72,457	40,217	161,322
Michigan	131,767	373,740	74,877	192,099	79,700	223,725
New York	52,608	79,476	32,903	73,093	30,135	58,571
South Dakota	320	2,650	2,900	7,750	3,615	9,618
Virginia	6,838	20,336	6,350	20,782	5,959	22,574
Other States	29,420	109,491	20,235	138,942	17,115	94,146
Total	267,769	764,118	182,995	574,523	208,126	628,051

State.	1892.		1893.		1894.		1895.	
	Product.	Value.	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
California	....	....	....	....	....	....	5,158	$51,014
Colorado	....	....	....	....	....	....	1,371	8,281
Iowa	(a)	(a)	21,447	$55,538	17,906	$44,700	25,700	36,600
Kansas	46,016	$195,197	43,631	181,599	64,889	301,884	72,947	272,531
Michigan	139,557	306,527	124,590	303,921	79,958	189,620	66,519	174,007
New York	32,394	61,100	36,126	65,392	31,798	60,262	33,587	59,321
Ohio	(a)	(a)	(a)	(a)	20,827	69,597	21,662	71,204
South Dakota	....	....	5,150	12,550	4,295	16,050	6,400	20,600
Texas	....	....	....	....	6,925	27,300	10,750	36,511
Virginia	6,991	28,207	7,014	24,359	8,106	24,431	5,800	17,369
Other States	31,301	104,461	15,657	53,256	4,608	27,875	15,609	50,009
Total	256,259	695,492	253,615	696,615	239,312	761,719	265,503	797,447

a Included in other States.

Comparative statistics of gypsum production for eleven years—Continued.

State.	1896.		1897.		1898.		1899.	
	Product.	Value.	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
California	1,452	$11,738	(*a*)	(*a*)	3,800	$24,977	2,950	$11,950
Colorado	1,600	10,547	*b* 12,309	$50,355	*c* 5,390	23,712	*c* 5,675	24,954
Iowa	18,631	34,020	83,783	255,129	83,913	237,208	75,574	296,220
Kansas	49,435	148,371					85,046	247,690
Michigan	67,634	146,424	94,874	193,576	93,181	204,310	144,776	283,537
New York	23,325	32,812	33,440	78,684	31,655	81,969	52,149	105,533
Ohio	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
South Dakota	(*a*)	(*a*)	8,350	19,240	(*a*)	(*a*)	(*a*)	(*a*)
Texas	(*a*)	(*a*)	24,454	65,651	34,215	58,130	(*a*)	(*a*)
Virginia	5,955	17,264	6,374	16,899	8,378	23,388	11,480	32,043
Other States	56,222	172,168	25,398	76,880	31,106	101,586	108,585	282,153
Total	224,254	573,344	288,982	755,864	291,638	755,280	486,235	1,287,080

a Included in other States. *b* Including Indian Territory. *c* Includes Wyoming.

The following table shows the annual production of gypsum in the United States since 1880:

Production of gypsum in the United States since 1880.

Year.	Product.	Value.	Year.	Product.	Value.
	Short tons.			*Short tons.*	
1880	90,000	$400,000	1890	182,995	$574,523
1881	85,000	350,000	1891	208,126	628,051
1882	100,000	450,000	1892	256,259	695,492
1883	90,000	420,000	1893	253,615	696,615
1884	90,000	390,000	1894	239,312	761,719
1885	90,405	405,000	1895	265,503	797,447
1886	95,250	428,625	1896	224,254	573,344
1887	95,000	425,000	1897	288,982	755,864
1888	110,000	550,000	1898	291,638	755,280
1889	267,769	764,118	1899	486,235	1,287,080

IMPORTS.

The imports of gypsum are chiefly from Canada, the product from the Dominion being very pure and well adapted for the manufacture of plaster of paris. The following table exhibits the total amount and value of gypsum imported into the United States since 1867:

Gypsum imported into the United States from 1867 to 1899.

Year ending—	Ground or calcined.		Unground.		Value of manufactured plaster of paris.	Total value.
	Quantity.(a)	Value.	Quantity.	Value.		
	Long tons.		*Long tons.*			
June 30, 1867	....	$29,895	97,951	$95,386	....	$125,281
1868	....	33,988	87,694	80,362	....	114,350
1869	....	52,238	137,039	133,430	$844	186,512
1870	....	46,872	107,237	100,416	1,432	148,720
1871	....	64,465	100,400	88,256	1,292	154,013
1872	....	66,418	95,339	99,902	2,553	168,873
1873	....	35,628	118,926	122,495	7,336	165,459
1874	....	36,410	123,717	130,172	4,319	170,901
1875	....	52,155	93,772	115,664	3,277	171,096
1876	....	47,588	139,713	127,084	4,398	179,070
1877	....	49,445	97,656	105,629	7,843	162,917
1878	....	33,496	89,239	100,102	6,989	140,587
1879	....	18,339	96,963	99,027	8,176	125,542
1880	....	17,074	120,327	120,642	12,693	150,409
1881	....	24,915	128,607	128,107	18,702	171,724
1882	a 5,737	53,478	128,382	127,067	20,377	200,922
1883	4,291	44,118	157,851	152,982	21,869	218,969
1884	4,996	42,904	166,310	168,000	(b)	210,904
1885	6,418	54,208	117,161	119,544	....	173,752
1886	5,911	37,642	122,270	115,696	....	153,338
1887	4,814	37,736	146,708	162,154	....	199,890
Dec. 31, 1888	3,340	20,764	156,697	170,023	....	190,787
1889	5,466	40,291	170,965	179,849	....	220,140
1890	7,568	55,250	171,289	174,609	....	229,859
1891	9,560	97,316	110,257	129,003	....	226,319
1892	6,832	75,608	181,104	232,403	....	308,011
1893	3,363	31,670	164,300	180,254	....	211,924
1894	2,027	16,823	162,500	179,237	(b)	196,060
1895	3,295	21,526	192,549	215,705	10,352	247,583
1896	3,292	21,982	180,269	193,544	11,722	227,248
1897	2,664	17,028	163,201	178,686	16,715	212,429
1898	2,973	18,501	166,066	181,364	40,979	240,844
1899	3,265	19,250	196,579	220,603	58,073	297,926

a Quantity not reported previous to 1882.

b Not specified from 1884 to 1894, inclusive.

CANADIAN PRODUCTION AND EXPORTS.

As the imports of gypsum into the United States are principally from the Provinces of Ontario, New Brunswick, and Nova Scotia, in the Dominion of Canada, the following table, showing the production in and the exports from the Dominion, will be found interesting:

Production and exports of Canadian gypsum since 1886.

Year.	Production.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1886	162,000	$178,742	107,237	$114,736
1887	154,008	157,277	148,533	166,514
1888	175,887	179,393	124,515	133,238
1889	213,273	205,108	176,875	189,491
1890	226,509	194,033	175,111	193,899
1891	203,605	206,251	172,496	184,977
1892	241,048	241,127	175,518	194,304
1893	192,568	196,150	*a* 176,489	178,979
1894	223,631	202,031	162,412	160,082
1895	226,178	202,608	*a* 160,898	156,897
1896	207,032	178,061	200,857	205,641
1897	239,691	244,531	180,540	183,376
1898	219,256	230,440	180,350	193,515
1899	244,566	257,329	....	....

a Entire exports went to the United States.

WORLD'S PRODUCTION.

The United States is the second country in the world as a producer of gypsum. France leads with more than one-half the entire world's production. Canada follows the United States in importance, though in one year (1896) the output of Great Britain exceeded that of Canada.

The following table exhibits, in short tons, the amount of gypsum produced by the principal countries of the world in each year, for which statistics are available, since 1893:

The world's production of gypsum since 1893.

Year.	United States.		Great Britain.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1893	253, 615	$696, 615	158, 122	$287, 940	192, 568	$196, 150
1894	239, 312	761, 719	169, 102	321, 822	223, 631	202, 031
1895	265, 503	797, 447	196, 037	348, 400	226, 178	202, 608
1896	224, 254	573, 344	213, 028	361, 509	207, 032	178, 061
1897	288, 982	755, 864	203, 151	325, 513	239, 691	244, 531
1898	291, 638	755, 280	219, 549	345, 882	219, 256	230, 440

Year.	France.		German Empire.		India.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
1893	....	....	....	....	....	....	2, 357	$6, 625
1894	1, 693, 831	$2, 891, 365	....	....	3, 548	$1, 566	3, 104	9, 006
1895	2, 175, 448	3, 392, 768	23, 994	$11, 040	7, 511	2, 987	2, 093	5, 252
1896	1, 866, 498	2, 661, 200	31, 736	14, 598	8, 248	3, 130	1, 050	2, 590
1897	1, 845, 874	2, 673, 033	28, 821	13, 228	9, 025	3, 333	4, 167	8, 162
1898	1, 931, 712	2, 777, 816	28, 315	13, 166	....	....	4, 279	7, 551

SALT.[1]

By Edward W. Parker.

PRODUCTION.

Salt production in the United States shared to some extent in the general prosperity which was the distinguishing feature of the entire mining industry during 1899. The effect upon the salt-producing industry was shown more in the increase of output than in any enhancement of value. The total production in 1899, including the salt in brine used at chemical works in the manufacture of soda ash, bleaching powder, etc., amounted to 19,708,614 barrels of 280 pounds net. Compared with the output of 1898, which amounted to 17,612,634 barrels, the production in 1899 shows an increase of 2,095,980 barrels, or about 12 per cent. The value of the product increased from $6,212,554 in 1898 to $6,867,467 in 1899, a gain of $654,913, or about 10.5 per cent. There are few industries in the United States which have presented more regular growth during the twenty years covered by this series of reports than that of salt production. In 1880 the output amounted to 5,961,060 barrels, less than one-third the amount produced in 1899. From 1880 to 1890 the product showed an increase of about 50 per cent, while in the nine years from 1890 to 1899 the production has increased over 120 per cent. During the last sixteen years there has been but one exception to a regularly increasing yearly production. The exception was in 1889, when the production was about 50,000 barrels, or 0.6 per cent, less than that of 1888.

In spite of the rapid development of the salt-producing industry (or perhaps because of it) the business has not been a lucrative one, and in many cases operations have been carried on for several years with the balances on the wrong side of the ledger. Keen competition for trade at the sacrifice of profits has been one of the marked features of the industry, the producers of one region endeavoring to extend their

[1] The statistics of salt production in 1899 were collected by the writer as a special agent of the Twelfth Census. The schedules for the census investigation were prepared so as to include the inquiries made each year by the Geological Survey, and the results of these inquiries are presented in the following pages. It is not regarded necessary in this report to consider all the details covered by the census investigation. For the statistics of capital invested, labor, and wages, etc., the reader is referred to the census report.

spheres of influence into territory naturally tributary to other sections. In some cases, as in Michigan, where the salt blocks are operated in connection with other lines of business, the losses made on the salt sales could be made up, but in the majority of instances these conditions did not obtain. It is not surprising, therefore, that the year 1899 finds many of the salt-producing concerns combining interests that were previously antagonistic. In New York two combinations have been effected, one in the Onondaga and the other in the Warsaw district. Another combination has been formed by a number of Michigan producers. A fourth controls the greater part of the Hutchinson, Kans., product; and a fifth combines the more important interests along the shores of Great Salt Lake.

PRODUCTION BY STATES.

New York continues to hold first place among the salt-producing States, having surpassed Michigan in 1893. The production in New York includes the salt in brine used in the manufacture of soda ash, bicarbonate of soda, bleaching powder, etc. The total production of the State in 1899 was 7,489,105 barrels, or 38 per cent of the total production in the United States. The value of New York's salt product in 1899 was equal to 37 per cent of the total value. Compared with that of 1898 the production of salt in New York in 1899 showed an increase of a little more than 10 per cent, while the value increased only a little more than 7 per cent.

Michigan remains in second place, with a production of 7,117,382 barrels in 1899, an increase of 1,853,818 barrels, or 35 per cent over 1898. Salt in brine used at chemical works in Detroit is included with the production of that State, and is responsible for the large increase in 1899. Kansas and Ohio, the third and fourth States, respectively, both showed decreased production in 1899, but maintained their relative positions. The former declined from 1,882,329 barrels in 1898 to 1,645,350 barrels in 1899, and the latter from 1,682,247 barrels to 1,460,516 barrels. The production increased in Texas, and decreased in California, Utah, and West Virginia. The production of other States is assembled in one amount, as there are fewer than three producers in each of them. The census enumerators have secured reports from a few small producers in Massachusetts, Nevada, and Wyoming, and these States are added to the list of salt producers, the output being combined with that of other States. The salt made in Massachusetts, like that of California, is obtained by the evaporation of sea water. Practically all of the salt product of Utah is made on the shores of Great Salt Lake. In all the other States salt made by evaporation is from deep wells. All the product of Louisiana is mined rock salt. Rock salt is also mined in New York and Kansas, and to a very slight extent in California and Utah. The total product of rock salt in 1899

was 2,544,036 barrels, equivalent to about 357,200 short tons, or 318,900 long tons. The total production of brine salt in 1899 was 17,164,578 barrels. In 1898 the product consisted of 15,428,833 barrels of brine salt and 2,183,801 barrels of rock salt.

For several years some of the larger producers have been giving particular attention to the preparation of fancy grades of salt for table and dairy use, and have succeeded in practically driving English salt of these grades out of the market. The grater part of the salt reported under the head of "table and dairy" in the following tables consists of these specially prepared grades, but these amounts do not represent the total consumption of salt for table and dairy purposes. Owing to the expense necessarily incurred in freeing these salts from all impurities, the prices are higher than for other grades and the market is restricted to discriminating consumers. What is classed as common fine salt is used almost entirely for table and dairy purposes, and it is probable that a good portion of the common coarse is also so used.

In the following tables is exhibited the amount of each of the grades of salt produced in each State during 1898 and 1899:

Production of salt in 1898, by States and grades.

State.	Table and dairy.	Common fine.	Common coarse.	Packers'.	Coarse solar.	Rock.	Milling.	Other grades.	Total product.	Total value.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	
California	61, 430	7, 143	46, 786	10, 000	505, 507	21, 429	....	714	653, 009	$185, 848
Kansas	90, 104	918, 213	122, 393	334, 983	1, 364	414, 943	....	329	1, 882, 329	616, 591
Michigan	208, 050	4, 552, 908	466, 466	10, 375	21, 997	....	....	3, 768	5, 263, 564	1, 628, 081
New York	1, 254, 854	1, 240, 325	169, 811	23, 777	2, 493, 285	1, 556, 300	....	53, 446	6, 791, 798	2, 369, 323
Ohio	400, 035	1, 154, 964	26, 548	500	....	....	....	100, 200	1, 682, 247	826, 868
Pennsylvania	....	140, 000	14, 287	....	....	....	....	....	154, 287	46, 000
Texas	33, 000	198, 570	10, 000	....	10, 714	....	....	2, 000	254, 284	119, 700
Utah	55, 714	4, 086	....	....	42, 014	7, 857	156, 579	....	266, 250	103, 778
West Virginia	90, 000	140, 501	17, 167	....	....	....	....	....	247, 668	88, 462
Other States	5, 152	226, 418	213	....	2, 143	183, 272	....	....	417, 198	227, 903
Total	2, 198, 339	8, 583, 128	873, 671	379, 635	3, 077, 024	2, 183, 801	156, 579	160, 457	17, 612, 634	6, 212, 554

Production of salt in 1899, by States and grades.

State.	Table and dairy.	Common fine.	Common coarse.	Packers'.	Coarse solar.	Rock.	Milling.	Other grades.	Total product.	Total value, net.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	
California	128, 779	33, 571	128, 852	47, 143	284, 265	250	7, 200	12, 503	642, 563	$281, 741
Kansas	56, 524	47, 157	1, 072, 676		714	468, 029		250	1, 645, 350	546, 291
Michigan	233, 713	4, 070, 211	2, 734, 131	19, 119	17, 743			42, 465	7, 117, 382	2, 205, 924
Nevada	3, 000	357	2, 457				71	1, 786	7, 671	10, 084
New York	1, 028, 803	1, 078, 131	397, 664	4, 318	3, 094, 465	1, 866, 550		19, 174	7, 489, 105	2, 540, 426
Ohio	375, 739	887, 445	84, 982	112, 350					1, 460, 516	575, 864
Oklahoma Territory	1, 729	1, 773	968		778				5, 248	4, 704
Texas	31, 286	220, 000	44, 721		10, 000			6, 429	312, 436	204, 330
Utah	1, 592		62, 115		75, 893	357	88, 907	7, 271	236, 135	115, 100
West Virginia	5, 000	216, 534							221, 534	107, 987
All other States		328, 173	33, 651			208, 850			570, 674	275, 016
Total	1, 866, 165	6, 883, 352	4, 562, 217	182, 930	3, 483, 858	2, 544, 036	96, 178	89, 878	19, 708, 614	6, 867, 467

In the following table is presented the distribution of the total salt product of the United States, by grades, during the last seven years. It will be observed that the production of common fine salt has approximated 50 per cent of the total output during this period:

Production of salt in the United States, 1893 to 1899, inclusive, by grades.

Year.	Table and dairy.	Common fine.	Common coarse.	Packers'.	Solar.	Rock.	Milling.	Other grades.	Total product.	Total value.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	
1893	1, 791, 577	5, 478, 054	444, 498	96, 657	2, 110, 287	1, 884, 145	5, 141	6, 413	11, 816, 772	$4, 054, 668
1894	2, 839, 140	5, 281, 754	438, 074	103, 041	587, 305	2, 266, 606	95, 621	1, 356, 876	12, 968, 417	4, 739, 285
1895	2, 173, 123	6, 099, 480	280, 284	118, 801	983, 870	2, 089, 763	40, 107	1, 884, 221	13, 669, 649	4, 423, 084
1896	2, 230, 409	6, 598, 733	300, 365	163, 035	2, 531, 086	1, 783, 886	133, 271	109, 941	13, 850, 726	4, 040, 839
1897	2, 555, 278	6, 868, 798	516, 143	609, 378	3, 614, 491	1, 649, 459	....	159, 655	15, 973, 202	4, 920, 020
1898	2, 198, 339	8, 583, 128	873, 671	379, 635	3, 077, 024	2, 183, 801	156, 579	160, 457	17, 612, 634	6, 212, 554
1899	1, 866, 165	6, 883, 352	4, 562, 217	182, 930	3, 483, 858	2, 544, 036	96, 178	89, 878	19, 708, 614	6, 867, 467

PRODUCTION IN PREVIOUS YEARS.

In the following statement is shown the salt production of the United States for a period of twenty years. During this time the yearly output has more than trebled, much of the increased production being due to the displacement of foreign salt by that of domestic production, for while the domestic production in 1899 was more than three times what it was in 1880 the imports were only a little more than one-third, and, as will be shown in a subsequent table, the percentage of the total consumption furnished by imported salt has decreased from 36.5 in 1880 to 6.9 in 1899.

In reporting production some operators use the bushel as a unit of measurement, some adopt the short ton, some the barrel, and others state their production in pounds. For the sake of convenience, as well as on account of the necessity for a uniform unit in tabulation, the product of each State has been reduced to barrels. A barrel of salt contains 280 pounds, and is equal to 5 bushels of 56 pounds. A short ton contains 7½ barrels.

Production of salt by States and Territories from 1880 to 1899.

State or Territory.	1880.		1882.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	2,485,177	$2,271,913	3,037,317	$2,126,122
New York	1,749,641	1,107,760	1,668,036	834,018
Ohio	530,060	363,791	400,000	280,000
West Virginia	535,888	380,369	400,000	300,000
Louisiana	62,400	56,160		
California	176,949	120,650	214,200	150,000
Utah	96,760	60,280	92,820	130,000
Other States and Territories	324,185	467,643	600,000	500,000
Total	5,961,060	4,828,566	6,412,373	4,320,140

Production of salt by States and Territories from 1880 to 1899—Continued.

State or Territory.	1883.		1884.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	2, 894, 672	$2, 344, 684	3, 161, 806	$2, 392, 536
New York	1, 619, 486	680, 638	1, 788, 454	705, 978
Ohio	350, 000	231, 000	320, 000	201, 600
West Virginia	320, 000	211, 000	310, 000	195, 000
Louisiana	265, 215	141, 125	223, 964	125, 677
California	214, 286	150, 000	178, 571	120, 000
Utah	107, 143	100, 000	114. 285	80, 000
Nevada	21, 429	15, 000	17, 857	12, 500
Illinois, Indiana, Virginia, Tennessee, Kentucky, and other States and Territories	400, 000	377, 595	400, 000	364, 443
Total	6, 192, 231	4, 251, 042	6, 514, 937	4, 197, 734

State or Territory.	1885.		1886.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 297, 403	$2, 967, 663	3, 677, 257	$2, 426, 689
New York	2, 304, 787	874, 258	2, 431, 563	1, 243, 721
Ohio	306, 847	199, 450	400, 000	260, 000
West Virginia	223, 184	145, 070	250, 000	162, 500
Louisiana	299, 271	139, 911	299, 691	108, 372
California	221, 428	160, 000	214, 285	150, 000
Utah	107, 140	75, 000	164, 285	100, 000
Nevada	28, 593	20, 000	30, 000	21, 000
Illinois, Indiana, Virginia, Tennessee, Kentucky, and other States and Territories	250, 000	243, 993	240, 000	352, 763
Total	7, 038, 653	4, 825, 345	7, 707, 081	4, 825, 345

Production of salt by States and Territories from 1880 to 1899—Continued.

State or Territory.	1887.		1888.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 944, 309	$2, 291, 842	3, 866, 228	$2, 261, 743
New York	2, 353, 560	936, 894	2, 318, 483	1, 130, 409
Ohio	365, 000	219, 000	380, 000	247, 000
West Virginia	225, 000	135, 000	220, 000	143, 000
Louisiana	341, 093	118, 735	394, 385	134, 652
California	200, 000	140, 000	220, 000	92, 400
Utah	325, 000	102, 375	151, 785	32, 000
Kansas			155, 000	189, 000
Other States and Territories	250, 000	150, 000	350, 000	143, 999
Total	8, 003, 962	4, 093, 846	8, 055, 881	4, 374, 203

State or Territory.	1889.		1890.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 856, 929	$2, 088, 909	3, 837, 632	$2, 302, 579
New York	2, 273, 007	1, 136, 503	2, 532, 036	1, 266, 018
Ohio	250, 000	162, 500	231, 303	136, 617
West Virginia	200, 000	130, 000	229, 938	134, 688
Louisiana	325, 629	152, 000	273, 553	132, 000
California	150, 000	63, 000	162, 363	57, 085
Utah	200, 000	60, 000	427, 500	126, 100
Kansas	450, 000	202, 500	882, 666	397, 199
Other States and Territories	300, 000	200, 000	300, 000	200, 000
Total	8, 005, 565	4, 195, 412	8, 876, 991	4, 752, 286

Production of salt by States and Territories from 1880 to 1899—Continued.

State or Territory.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 966, 784	$2, 037, 289	3, 829, 478	$2, 046, 963
New York	2, 839, 544	1, 340, 036	3, 472, 073	1, 662, 816
Ohio	(*a*)	(*a*)	899, 244	394, 720
West Virginia	(*a*)	(*a*)		
Louisiana	173, 714	102, 375	200, 000	100, 000
California	200, 949	90, 303	235, 774	104, 938
Utah	969, 000	265, 350	1, 292, 471	340, 442
Nevada	60, 799	39, 898	22, 929	22, 806
Kansas	855, 536	304, 775	1, 480, 100	773, 989
Illinois	39, 670	34, 909	60, 000	48, 000
Virginia	70, 442	70, 425	60, 000	50, 000
Pennsylvania			25, 571	10, 741
Texas			121, 250	99, 500
Other States and Territories	811, 507	430, 761		
Total	9, 987, 945	4, 716, 121	11, 698, 890	5, 654, 915

State or Territory.	1893.		1894.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
New York	5, 662, 074	$1, 870, 084	6, 270, 588	$1, 999, 146
Michigan	3, 057, 898	888, 837	3, 341, 425	1, 243, 619
Kansas	1, 277, 180	471, 543	1, 382, 409	529, 392
Ohio	543, 963	209, 393	528, 996	187, 432
West Virginia	210, 736	68, 222	194, 532	51, 947
Louisiana	191, 430	97, 200	186, 050	86, 134
California	292, 858	137, 962	332, 246	172, 678
Utah	189, 006	130, 075	268, 186	209, 077
Nevada	6, 559	4, 481	3, 670	4, 030
Illinois	59, 161	30, 168	50, 000	27, 500
Virginia			64, 222	43, 580
Pennsylvania	280, 343	136, 436	203, 236	83, 750
Texas	126, 000	110, 267	142, 857	101, 000
Total	11, 897, 208	4, 154, 668	12, 968, 417	4, 739, 285

a Included in "Other States."

Production of salt by States and Territories from 1880 to 1899—Continued.

State or Territory.	1895.		1896.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
New York	6, 832, 331	$1, 943, 398	6, 069, 040	$1, 896, 681
Michigan	3, 343, 395	1, 048, 251	3, 164, 238	718, 408
Kansas	1, 341, 617	483, 701	1, 408, 607	397, 296
Ohio	781, 033	326, 520	1, 662, 358	432, 877
West Virginia	176, 720	63, 041	176, 921	50, 717
Louisiana	159, 771	78, 169	(*a*)	(*a*)
California	318, 935	158, 683	430, 121	198, 963
Utah	294, 485	121, 762	279, 800	96, 550
Nevada	7, 000	5, 600	(*a*)	(*a*)
Illinois	67, 119	31, 548	(*a*)	(*a*)
Virginia	65, 000	40, 000	(*a*)	(*a*)
Pennsylvania	157, 243	67, 411	198, 596	56, 717
Texas	125, 000	55,000	(*a*)	(*a*)
Other States and Territories			461, 045	192, 630
Total	13, 669, 649	4, 423, 084	13, 850, 726	4, 040, 839

State or Territory.	1897.		1898.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
New York	6, 805, 854	$1, 948, 759	6, 791, 798	$2, 369, 323
Michigan	3, 993, 225	1, 253, 403	5, 263, 564	1, 628, 081
Ohio	1, 575, 414	421, 757	1, 682, 247	826, 868
Kansas	1, 538, 327	488, 022	1, 882, 329	616, 591
California	470, 893	162, 654	653, 009	185, 848
West Virginia	441, 893	160, 129	247, 668	88, 462
Utah	405, 179	196, 056	266, 250	103, 778
Pennsylvania	164, 287	45, 107	154, 287	46, 000
Other States	578, 130	244, 133	671, 482	347, 603
Total	15, 973, 202	4, 920, 020	17, 612, 634	6, 212, 554

a Included in "Other States."

Production of salt by States and Territories from 1880 to 1899—Continued.

State or Territory.	1899.	
	Quantity.	Value.
	Barrels.	
New York	7,489,105	$2,540,426
Michigan	7,117,382	2,205,924
Kansas	1,645,350	546,291
Ohio	1,460,516	575,864
California	642,563	281,741
Texas	312,436	204,330
West Virginia	221,534	107,987
Utah	236,135	115,100
Other States *a*	570,674	275,016
Total	19,708,614	6,867,467

a Includes Illinois, Louisiana, Massachusetts, Nevada, Oklahoma, Pennsylvania, and Virginia.

DOMESTIC CONSUMPTION.

The following table shows approximately the amount of salt consumed in the United States each year since 1880. It is assumed that stocks on hand at the first of each year were without material variation, and that the domestic production, plus the imports and minus the exports, will fairly represent the domestic consumption. It appears from this table that the amount of salt consumed in the United States in 1899 was 20,968,980 barrels. This amount is almost exactly double the consumption in 1889.

A glance at the table will show that in the ten years from 1880 to 1889, inclusive, there was little change in the amount of salt consumed, averaging a little less than 10,000,000 barrels per year and having an extreme range from 9,281,100 barrels to 10,574,975 barrels. Since 1889, however, there has been a decided increase, and in only one year was the consumption less than in the preceding year. This was the panic year of 1893. In order to show more strikingly the increase in consumption during the last decade, it may be considered in comparison with the increase in population. Reducing barrels to pounds, the consumption in 1880 was 2,627,593,640 pounds, in 1890 it was 2,749,546,240 pounds, and in 1899 it was 5,871,314,400 pounds. The population of the United States in 1880 was 50,155,783, in 1890 it was 62,640,335, while a conservative estimate for 1899 would be 74,300,000. From this it is seen that the per capita consumption in the three years was, respectively, 52.4, 43.9, and 78.7 pounds. Part of this increased consumption in the last ten years is doubtless due to the development of the chlori-

nation process for the treatment of gold ores, but the most important factor has been the establishment of the great meat-packing houses of our Western cities and the increase in the manufacture of dairy products.

Another interesting feature presented in this table is the steadily decreasing proportion of foreign salt entering into domestic consumption. In the five years from 1880 to 1884 the amount of salt imported averaged somewhat more than one-third the total consumption. In 1890 this percentage had decreased nearly one-half, to 17.2. It had decreased further in 1893 to 9.5 per cent. There was a reaction in 1894, 1895, and 1896, when, under the Wilson tariff, salt was on the free list and the proportion of foreign salt in the domestic consumption increased. It decreased again in 1897, 1898, and 1899, falling in the last two years to 7.02 per cent and 6.4 per cent, respectively.

The following table presents the production, imports, exports, and consumption since 1880:

Supply of salt for domestic consumption from 1880 to 1899.

Source.	1880.	1881.	1882.	1883.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Domestic production	5, 961, 060	*a* 6, 000, 000	6, 412, 373	6, 192, 231
Imports	3, 427, 639	3, 839, 994	3, 085, 168	3, 099, 698
Total	9, 388, 699	9, 839, 994	9, 497, 541	9, 291, 929
Exports	4, 436	9, 091	8, 417	10, 829
Domestic consumption	9, 384, 263	9, 830, 903	9, 489, 124	9, 281, 100
Increase over preceding year	....	446, 640	*b* 341, 779	*b* 208, 024
Percentage of imports to total consumption	36. 5	39. 1	32. 5	33. 4
Source.	**1884.**	**1885.**	**1886.**	**1887.**
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Domestic production	6, 514, 937	7, 038, 653	7, 707, 081	8, 003, 962
Imports	3, 246, 349	3, 227, 380	2, 818, 623	2, 587, 745
Total	9, 761, 286	10, 266, 033	10, 525, 704	10, 591, 707
Exports	14, 003	14, 649	17, 246	16, 732
Domestic consumption	9, 747, 283	10, 251, 384	10, 508, 458	10, 574, 975
Increase over preceding year	466, 183	504, 101	257, 074	66, 517
Percentage of imports to total consumption	33. 3	31. 5	26. 8	24. 5

a Estimated. *b* Decrease.

Supply of salt for domestic consumption from 1880 to 1899—Continued.

Source.	1888.	1889.	1890.	1891.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Domestic production	8, 055, 881	8, 005, 565	8, 876, 991	9, 987, 945
Imports	2, 232, 253	1, 833, 452	1, 838, 024	1, 694, 048
Total	10, 288, 134	9, 839, 017	10, 715, 015	11, 681, 993
Exports	19, 140	19, 209	17, 597	15, 889
Domestic consumption	10, 268, 994	9, 819, 808	10, 697, 418	11, 666, 104
Increase over preceding year	*a* 305, 981	*a* 449, 186	877, 610	968, 686
Percentage of imports to total consumption	21. 7	18. 7	17. 2	14. 5

Source.	1892.	1893.	1894.	1895.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Domestic production	11, 698, 890	11, 897, 208	12, 968, 417	13, 669, 649
Imports	1, 633, 419	1, 244, 711	1, 550, 555	1, 996, 970
Total	13, 332, 309	13, 141, 919	14, 518, 972	15, 666, 619
Exports	18, 603	20, 686	38, 763	36, 855
Domestic consumption	13, 313, 706	13, 121, 233	14, 480, 209	15, 629, 764
Increase over preceding year	1, 647, 602	*a* 192, 473	1, 358, 976	1, 149, 555
Percentage of imports to total consumption	12. 3	9. 49	10. 71	12. 78

Source.	1896.	1897.	1898.	1899.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Domestic production	13, 850, 726	15, 973, 202	17, 612, 634	19, 708, 614
Imports	1, 858, 614	1, 493, 033	1, 325, 212	1, 350, 366
Total	15, 709, 340	17, 466, 235	18, 937, 846	21, 058, 980
Exports	63, 391	54, 195	61, 715	90, 000
Domestic consumption	15, 645, 949	17, 412, 040	18, 876, 131	20, 968, 980
Increase over preceding year	16, 185	1, 766, 091	1, 464, 091	2, 092, 849
Percentage of imports to total consumption	11. 88	8. 57	7. 02	6. 4

a Decrease.

IMPORTS AND EXPORTS.

The imports of salt into the United States as reported by the Bureau of Statistics of the Treasury Department show that from 1867 to 1881 there was a persistent increasing tendency from 483,775,185 pounds in the former year to 1,075,198,397 pounds in 1881. From 1881 the imports decreased almost as steadily until 1893. The decrease was largely in the imports of fine salt, due to the successful efforts of American manufacturers to produce table, dairy, and other special grades of salt equal, if not superior, in quality and price to the imported article. The tariff act of 1894 placed salt upon the free list, and importations increased from 348,519,173 pounds in 1893 to 434,155,708 pounds in 1894, and to nearly 560,000,000 pounds in 1895. In 1896 the imports of foreign salt amounted to 520,411,822 pounds. The tariff act of 1897 returned salt to the dutiable list. Salt in bags, barrels, or other packages is now subjected to a duty of 12 cents per 100 pounds (33.6 cents per barrel), and salt in bulk is taxed at the rate of 8 cents per 100 pounds, or 22.4 cents per barrel. The duty on imported salt in bond used in curing fish taken by vessels licensed to engage in the fisheries and in curing fish on the navigable waters of the United States, or on salt used in curing meats for export, may be remitted. The quantity of salt imported in 1897 was nearly 20 per cent less than in 1896, the total amounting to 418,049,214 pounds, while in 1898 the imports fell off to 371,059,452 pounds, with one exception the smallest amount reported in thirty-two years. In 1899 the imports increased slightly to 378,102,567 pounds, a gain of 7,043,115 pounds over 1898, but the value showed a decline of about $9,000. Since 1867 the imports have been as follows:

Salt imported and entered for consumption in the United States, 1867 to 1899, inclusive.

Year ending—	In bags, barrels, and other packages.		In bulk.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
June 30, 1867	254, 470, 862	$696, 570	229, 304, 323	$336, 302
1868	308, 446, 080	915, 546	219, 975, 096	365, 458
1869	297, 382, 750	895, 272	256, 765, 240	351, 168
1870	288, 479, 187	797, 194	349, 776, 433	507, 874
1871	283, 993, 799	800, 454	274, 730, 573	355, 318
1872	258, 232, 807	788, 893	257, 637, 230	312, 569
1873	239, 494, 117	1, 254, 818	388, 012, 132	525, 585
1874	358, 375, 496	1, 452, 161	427, 294, 209	649, 838
1875	318, 673, 091	1, 200, 541	401, 270, 315	549, 111
1876	331, 266, 140	1, 153, 480	379, 478, 218	462, 106
1877	359, 005, 742	1, 059, 941	444, 044, 370	532, 831
1878	352, 109, 963	1, 062, 995	414, 813, 516	483, 909
1879	375, 286, 472	1, 150, 018	434, 760, 132	532, 706
1880	400, 970, 531	1, 180, 082	449, 743, 872	548, 425
1881	412, 442, 291	1, 242, 543	529, 361, 041	658, 068
1882	329, 969, 300	1, 086, 932	399, 100, 228	474, 200
1883	312, 911, 360	1, 035, 946	412, 938, 686	451, 001
1884	340, 759, 010	1, 093, 628	441, 613, 517	433, 827
1885	351, 276, 969	1, 030, 029	412, 322, 341	386, 858
Dec. 31, 1886	319, 232, 750	966, 993	366, 621, 223	371, 000
1887	275, 774, 571	850, 069	343, 216, 331	328, 201
1888	238, 921, 421	620, 425	272, 650, 231	246, 022
1889	180, 906, 293	627, 134	234, 499, 635	249, 232
1890	172, 611, 041	575, 260	243, 756, 044	252, 848
1891	150, 033, 182	492, 144	220, 309, 985	224, 569
1892	150, 799, 014	488, 108	201, 366, 103	196, 371
1893	98, 037, 648	358, 575	146, 945, 390	63, 404
1894	60, 793, 685	206, 229	101, 525, 281	86, 718
1895	601, 086	1, 723	1, 874, 644	1, 874
1896	350, 620	814	1, 627, 030	1, 640
1897	36, 801, 048	114, 072	50, 775, 105	46, 412
1898	114, 573, 146	361, 366	178, 458, 117	165, 784
1899	119, 720, 721	372, 921	158, 263, 237	133, 862

Salt imported and entered for consumption in the United States, etc.—Continued.

Year ending—	For the purpose of curing fish.		Not elsewhere specified.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.		
June 30—	*Pounds.*		*Pounds.*		*Pounds.*	
1867....	....	....	....	....	483, 775, 185	$1, 032, 872
1868....	....	....	....	....	528, 421, 176	1, 281, 004
1869....	....	....	....	....	554, 147, 990	1, 246, 440
1870....	68, 597, 023	$87, 048	....	....	706, 852, 643	1, 392, 116
1871....	64, 671, 139	66, 008	....	....	623, 395, 511	1, 221, 780
1872....	57, 830, 929	60, 155	....	....	773, 700, 966	1, 161, 617
1873....	86, 756, 628	86, 193	....	....	714, 262, 877	1, 866, 596
1874....	105, 613, 913	126, 896	....	....	891, 283, 618	2, 228, 895
1875....	110, 294, 440	119, 607	....	....	830, 237, 846	1, 869, 259
1876....	118, 760, 638	126, 276	....	....	829, 504, 996	1, 741, 862
1877....	132, 433, 972	140, 787	....	....	935, 484, 084	1, 733, 559
1878....	100, 794, 611	96, 898	....	....	867, 718, 090	1, 643, 802
1879....	94, 060, 114	95, 841	....	....	904, 106, 718	1, 778, 565
1880....	109, 024, 446	119, 667	....	....	959, 738, 849	1, 848, 174
1881....	133, 395, 065	144, 347	....	....	1, 075, 198, 397	2, 044, 958
1882....	134, 777, 569	147, 058	....	....	863, 847, 097	1, 708, 190
1883....	142, 065, 557	154, 671	....	....	867, 915, 603	1, 641, 618
1884....	126, 605, 276	122, 463	....	....	908, 977, 803	1, 649, 918
1885....	140, 067, 018	121, 429	....	....	903, 666, 328	1, 538, 316
Dec. 31—						
1886....	103, 360, 362	94, 721	....	....	789, 214, 335	1, 432, 714
1887....	105, 577, 947	107, 089	....	....	724, 568, 849	1, 285, 359
1888....	113, 459, 083	111, 120	....	....	625, 030, 735	977, 577
1889....	97, 960, 624	100, 123	....	....	513, 366, 552	976, 489
1890....	98, 279, 719	96, 648	....	....	514, 646, 804	924, 756
1891....	103, 990, 324	89, 196	....	....	474, 333, 491	805, 909
1892....	105, 192, 086	90, 327	....	....	457, 357. 203	774, 806
1893....	103, 536, 135	87, 749	....	....	348, 519, 173	509, 728
1894....	93, 723, 885	79, 482	178, 112, 857	$263, 707	434, 155, 708	636, 136
1895....	8, 668, 490	12, 195	548, 007, 449	739, 122	559, 151, 669	754, 914
1896....	8, 351, 913	11, 814	510, 082, 259	687, 890	520, 411, 822	702, 158
1897....	32, 961, 953	33, 962	297, 511, 108	370, 592	418, 049, 214	565, 038
1898....	78, 028, 189	61, 503	....	....	371, 059, 452	588, 653
1899....	100, 118, 609	72, 899	....	....	378, 102, 567	579, 682

Salt of domestic production exported from the United States from 1790 to 1899, inclusive.

Year ending—	Quantity.	Value.	Year ending—	Quantity.	Value.
	Bushels.			*Bushels.*	
Sept. 30, 1790	31,935	$8,236	June 30, 1864	635,519	$296,088
1791	4,208	1,052	1865	589,537	358,109
1830	47,488	22,978	1866	70,644	300,980
1831	45,847	26,848	1867	605,825	304,030
1832	45,072	27,914	1868	624,970	289,936
1833	25,069	18,211	1869	442,947	190,076
1834	89,064	54,007	1870	298,142	119,582
1835	126,230	46,483	1871	120,156	47,115
1836	49,917	31,943	1872	42,603	19,978
1837	99,133	58,472	1873	73,323	43,777
1838	114,155	67,707	1874	31,657	15,701
1839	264,337	64,272	1875	47,094	16,273
1840	92,145	42,246	1876	51,014	18,378
1841	215,084	62,765	1877	65,771	20,133
1842	110,400	39,064	1878	72,427	24,968
June 30, 1843 *a*	40,678	10,262	1879	43,710	13,612
1844	157,529	47,755	1880	22,179	6,613
1845	131,500	45,151	1881	45,455	14,752
1846	117,627	30,520	1882	42,085	18,265
1847	202,244	42,333	1883	54,147	17,321
1848	219,145	73,274	1884	70,014	26,007
1849	312,063	82,972	1885	*b*4,101,587	26,488
1850	319,175	75,103	Dec. 31, 1886	4,828,863	29,580
1851	344,061	61,424	1887	4,685,080	27,177
1852	1,467,676	89,316	1888	5,359,237	32,986
1853	515,857	119,729	1889	5,378,450	31,405
1854	548,185	159,026	1890	4,927,022	30,079
1855	536,073	156,879	1891	4,448,846	23,771
1856	698,458	311,495	1892	5,208,935	28,399
1857	576,151	190,699	1893	5,792,207	38,375
1858	533,100	162,650	1894	10,853,759	46,780
1859	717,257	212,710	1895	7,203,024	30,939
1860	475,445	129,717	1896	10,711,314	43,202
1861	537,401	144,046	1897	11,593,321	52,320
1862	397,506	228,109	1898	17,280,193	63,624
1863	584,901	277,838	1899	25,200,191	86,465

a Nine months.

b Pounds from 1885.

In connection with the above tables it is interesting to note the sources from which our imported salt is obtained and the markets supplied by our exports of domestic salt. For this purpose the following tables, showing the countries from which we import, the amount and value of the salt received from each, and also the amount and value of the salt exported to each country, are given for the three fiscal years ending June 30, 1896, 1897, and 1898. It will be observed that Great Britain is the principal exporter of salt to the United States, the amount imported from the United Kingdom averaging somewhat over 50 per cent of the total imports. Next in importance are the West Indian Islands (chiefly British), and after these comes Italy. The amount received from other countries is comparatively small.

The principal exports are through the port of San Francisco, and to the Central American States, Mexico, the Hawaiian Islands, Japan, and Asiatic Russia. About 25 per cent, or a little more, goes across the Great Lakes to the Dominion of Canada.

The imports and exports for the past three fiscal years, with the countries from which imported and to which exported, have been as follows:

Imports of salt during the fiscal years ending June 30, 1897, 1898, and 1899.

Country from which exported.	Free.		Dutiable. (a)	
	Quantity.	Value.	Quantity.	Value.
Year ending June 30, 1897:	*Pounds.*		*Pounds.*	
United Kingdom	312, 975, 950	$507, 972	1, 120, 000	$1, 217
Italy	82, 373, 539	53, 306		
Canada	461, 440	1, 194	3, 453, 447	8, 164
West Indies	187, 323, 130	172, 242		
Other countries	460	5	10, 650, 390	9, 798
Total	583, 134, 519	734, 719	15, 223, 837	19, 179
Year ending June 30, 1898:				
United Kingdom	13, 011, 441	23, 117	163, 796, 501	362, 913
Italy	3, 413, 600	2, 138	59, 803, 075	38, 478
Canada			5, 054, 777	12, 506
West Indies	9, 628, 849	8, 913	78, 294, 591	69, 170
Other countries			9, 251, 272	7, 424
Total	26. 053. 890	34. 168	316, 200, 216	490, 491

Country from which exported.	Dutiable and free.	
	Quantity.	Value.
Year ending June 30, 1899:	*Pounds.*	
United Kingdom	155, 802, 586	$401, 397
Italy	68, 133, 438	42, 562
Canada	3, 850, 891	7, 719
West Indies	131, 962, 790	102, 825
Other countries	4, 033, 228	4, 419
Total	363, 782, 933	558, 922

a The tariff act of 1894 provided that salt should be free of duty, but when in bags or other packages the coverings should pay duty as if imported separately, and salt imported from countries imposing a duty on salt exported from the United States should pay the rate of duty imposed prior to the act of 1894. Under the tariff act of 1897 salt in bulk is subject to a duty of 8 cents per 100 pounds; salt in packages, 12 cents per 100 pounds, with duty remitted on salt used in curing meats for export, or in curing fish on the navigable waters of the United States.

Exports of salt during the fiscal years ending June 30, 1897, 1898, and 1899.

Country to which exported.	Year ending June 30, 1897.		Year ending June 30, 1898.		Year ending June 30, 1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	95,000	$1,945	570,507	$4,554	45,230	$360
Bermuda	118,989	1,136	181,806	1,466	155,088	1,589
British Honduras	7,330	89	28,150	241	19,951	223
Dominion of Canada:						
Nova Scotia, New Brunswick, etc	20,070	366	114,452	1,261	30,383	572
Quebec, Ontario, etc	1,667,317	4,349	2,247,640	7,090	2,415,988	6,832
British Columbia	425,257	3,529	1,119,949	5,663	2,012,080	7,755
Newfoundland and Labrador	51,870	497	109,700	1,226	107,320	1,028
Central American States:						
Costa Rica	45,466	370	111,820	864	140,945	1,058
Guatemala	476,194	2,967	207,470	982	693,797	4,714
Honduras	41,330	540	101,310	1,006	99,242	1,004
Nicaragua	180,451	1,715	266,240	2,481	270,931	3,216
Salvador	99,000	468	251,640	1,005	37,500	146
Mexico	480,559	4,529	1,210,258	8,367	1,713,796	10,872
West Indies:						
British	124,104	649	235,263	924	129,415	512
Danish	----------	-------	1,700	17	500	3
Dutch and French *a*	2,295	26	7,455	82	10,180	120
Haiti	7,560	96	10,298	115	4,793	60
Porto Rico	----------	-------	----------	-------	2,426	19
Santo Domingo	75,274	868	56,364	662	27,744	322
Cuba	52,000	560	17,372	118	853,572	5,311
Colombia	33,749	275	48,783	407	112,057	699
Japan	250,000	1,181	240,000	804	1,204,000	2,810
China	----------	-------	150,000	1,500	114,200	245
Russia, Asiatic	5,206,180	12,444	8,883,000	20,745	14,093,100	32,020
French Oceanica	102,600	517	107,110	450	103,950	500
British Australasia	52,927	272	86,830	893	169,100	859
Hawaiian Islands	462,700	2,223	613,500	2,776	634,970	2,843
British Africa	14,000	125	15,855	148	14,000	145
Other countries	5,990	60	78,742	504	40,376	478
Total	10,100,712	41,832	17,073,214	66,151	25,256,634	86,315

a In 1899 French only.

WORLD'S PRODUCTION.[1]

With the exception of the production of the United States and Canada, the latest statistics available for the countries contributing to the world's supply of salt are for the calendar year 1898. The subsequent table, accordingly, brings the output for these countries down to that year only. It shows that the United States, which since 1892 has held second place among the countries of the world, became the leader in 1897, ranking Great Britain by about 5 per cent. This advantage was increased in 1898 by a gain in the production of the United States and a decrease in the output of Great Britain. The table further shows that while the production in the United States has increased steadily since 1890, the output of Great Britain has exhibited an annual decrease since 1894. Another fact presented by the table is that the United States contributed 20 per cent of the world's supply in 1898; Great Britain 17 per cent; Russia 14 per cent; Germany 12 per cent; France and India each about 9 per cent, and Austria-Hungary 5 per cent. None of the other salt-producing countries averages as much as 5 per cent of the total a year.

Austria-Hungary, whose product is only 5 per cent of the world's total, furnishes nearly 50 per cent of the value. In this case the salt-producing industry is a government monopoly and one of its principal sources of revenue. The production of Austria-Hungary amounted in 1898 to less than one-fourth of that of the United States, but the value of the product in that country was more than three times that of the United States and more than six times that of Great Britain. The first cost of salt to the consumer in the United States is about $2 per ton; in Austria-Hungary it is over $30 per ton. Under such conditions the small production is readily accounted for. Cheapness has increased the consumption of salt in the United States and developed many industries dependent upon it. The high prices charged for it by the Government of Austria-Hungary have restricted its production and consumption, and it is safe to assume that little salt is wasted by the people of that country.

The production of salt in Turkey is also a government monopoly and no statistics are published. The following table shows the production, in short tons, of salt by the principal countries of the world for such years as the figures are obtainable since 1890:

[1] For sake of convenience the production of salt in all countries has been reduced in this paragraph to short tons.

The world's salt production.

Year.	United States.		Great Britain.		France. (*a*)	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1890....	1, 242, 778	$4, 752, 286	2, 403, 462	$5, 354, 400	955, 434	$3, 458, 174
1891....	1, 398, 312	4, 040, 839	2, 288, 800	4, 737, 596	932, 292	2, 868, 945
1892....	1, 637, 845	5, 654, 915	2, 191, 307	4, 177, 795	1, 100, 898	3, 318, 366
1893....	1, 665, 609	4, 154, 668	2, 154, 912	3, 565, 827	1, 248, 566	3, 291, 422
1894....	1, 815, 438	4, 739, 285	2, 504, 221	3, 703, 601	1, 001, 498	2, 762, 216
1895....	1, 913, 751	4, 423, 084	2, 434, 043	3, 442, 292	988, 273	2, 421, 378
1896....	1, 939, 102	4, 040, 839	2, 265, 040	3, 233, 073	1, 178, 038	2, 492, 402
1897....	2, 236, 248	4, 920, 020	2, 131, 912	3, 017, 564	1, 070, 290	2, 236, 755
1898....	2, 465, 769	6, 212, 554	2, 103, 718	3, 016, 011	1, 132, 415	2, 156, 196

Year.	German Empire.		Italy.		Austria-Hungary. (*b*)	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1890....	1, 156, 769	$3, 750, 642	524, 552	$999, 933	515, 736	$17, 863, 887
1891....	1, 289, 560	3, 903, 438	492, 144	927, 812	508, 022	17, 436, 392
1892....	1, 286, 365	3, 968, 650	461, 738	857, 692	490, 390	16, 069, 952
1893....	1, 293, 748	4, 016, 909	466, 146	990, 283	524, 552	16, 475, 059
1894....	1, 386, 316	4, 143, 710	477, 166	912, 118	565, 326	17, 256, 516
1895....	1, 347, 014	4, 131, 945	526, 370	1, 030, 350	530, 062	17, 075, 675
1896....	1, 436, 258	4, 204, 910	497, 915	935, 466	538, 951	15, 497, 873
1897....	1, 306, 684	3, 730, 950	507, 778	968, 031	554, 078	15, 725, 518
1898....	1, 510, 511	3, 755, 201	497, 002	802, 108	639, 830	19, 535, 222

Year.	Russia.		Spain.		India.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1890....	1, 531, 736	$2, 613, 611	678, 531	$1, 750, 444	1, 159, 395	$1, 948, 104
1891....	1, 489, 008	4, 978, 589	642, 292	1, 687, 300	1, 139, 468	1, 690, 294
1892....	1, 608, 595	4, 627, 700	750, 059	2, 505, 855	1, 008, 330	1, 750, 317
1893....	1, 489, 687	4, 281, 970	166, 913	82, 076	940, 547	1, 546, 597
1894....	1, 493, 572	3, 317, 160	227, 645	85, 786	1, 452, 654	2, 538, 121
1895....	1, 705, 896	3, 887, 090	359, 604	918, 775	1, 282, 522	2, 058, 678
1896....	1, 484, 782	4, 917, 250	574, 970	1, 113, 494	1, 131, 472	1, 753, 371
1897....	1, 682, 337	4, 357, 253	560, 484	1, 118, 720	1, 033, 601	1, 560, 415
1898....	(*c*)	(*c*)	527, 858	989, 704	(*c*)	(*c*)

a Includes product of Algeria.
b Government monopoly.
c Latest available figures are used in making up the total for the world, on next page.

The world's salt production—Continued.

Year.	Canada.		Other countries.		The world.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
1890	43, 754	$198, 857	....	....	10, 212, 147	$42, 690, 338
1891	45, 021	161, 179	....	....	10, 224, 919	42, 432, 384
1892	45, 486	162, 041	....	....	10, 581, 013	43, 093, 283
1893	62, 324	195, 926	....	....	10, 013, 004	38, 600, 737
1894	57, 199	170, 687	*a* 2, 772	$9, 515	10, 983, 807	39, 638, 715
1895	52, 376	160, 455	*b* 159, 129	1, 155, 738	11, 299, 040	40, 605, 460
1896	43, 960	169, 693	*c* 128, 959	408, 111	11, 219, 447	38, 766, 482
1897	51, 348	225, 730	*c* 35, 373	204, 468	11, 170, 133	38, 065, 424
1898	57, 126	248, 639	*d* 463, 707	1, 567, 034	12, 113, 874	44, 200, 337

a Cape Colony and Ceylon.

b Cape Colony, Ceylon, Greece, Bosnia, and Herzegovina.

c Cape Colony, Greece, Bosnia, and Herzegovina.

d In addition to this amount Brazil produced 26,882; Peru, 19,836; Roumania, 119,103; Switzerland, 52,116; Turkey, 247,663. Total, 465,600 short tons, for which no value is given.

MICA.

PRODUCTION.

The mica production of the United States in 1899 consisted of 108,570 pounds of sheet mica, valued at $70,587, and 1,505 short tons of scrap mica, worth $30,878. The production in 1898 amounted to 129,520 pounds of sheet and 3,999 short tons of scrap, valued, respectively, at $103,534 and $27,564. This indicates a decrease of 20,950 pounds in the production of sheet mica in 1899 as compared with the preceding year, with a loss in value of $32,947. The production of scrap mica was 2,494 short tons less than in 1898, a decrease of over 60 per cent, while there was an increase of $3,314, or 12 per cent in value.

The reason for the decrease in the domestic production in 1899 may be ascribed to the large importations of foreign mica. The amount of unmanufactured mica imported into the United States in 1899 was 1,709,839 pounds, nearly double the imports in 1898, while the total value of all mica imported was the largest ever recorded.

The development of the use of electricity during the past few years has created a demand for mica as an insulating material. Much of the small-sized mica, formerly of little value, if not altogether unsalable, now finds a market among electrical manufacturers. Part of this small mica is reported in the sheet-mica product, and as it sells for much less than the larger sizes, which are used in the manufacture of heating stoves, lamp chimneys, etc., it has the effect of making an apparent decline in values. On the other hand, part of the small-sized sheet mica used for electrical purposes is reported as scrap, and in this case causes an augmented value. In 1896 the value of the scrap mica produced and reported as such was only $1,750. It increased to $14,452 in 1897, to $27,564 in 1898, and to $30,878 in 1899.

The following table shows the annual production of mica in the United States since 1880:

Production of mica since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1880	81,669	$127,825	1894 Sheet	35,943	52,388
1881	100,000	250,000	1894 Scrap	*a* 191	
1882	100,000	250,000	1895 Sheet	44,325	55,831
1883	114,000	285,000	1895 Scrap	*a* 148	
1884	147,410	368,525	1896 Sheet	49,156	65,441
1885	92,000	161,000	1896 Scrap	*a* 222	1,750
1886	40,000	70,000	1897 Sheet	82,676	80,774
1887	70,000	142,250	1897 Scrap	*a* 740	14,452
1888	48,000	70,000	1898 Sheet	129,520	103,534
1889	49,500	50,000	1898 Scrap	*a* 3,999	27,564
1890	60,000	75,000	1899 Sheet	108,570	70,587
1891	75,000	100,000	1899 Scrap	*a* 1,505	30,878
1892	75,000	$100,000			
1893 Sheet	51,111	88,929			
1893 Scrap	*a* 156				

a Short tons.

The production of mica during 1898 and 1899, by States, was as follows:

Production of mica in 1898, by States.

State.	Sheet mica.	Scrap mica.
	Pounds.	*Short tons.*
New Hampshire	43,843	2,977
North Carolina	84,687	1,022
South Dakota	990	
Total	129,520	3,999

Production of mica in 1899, by States.

State.	Sheet mica.	Scrap mica.
	Pounds.	*Short tons.*
New Hampshire	16,113	165
New Mexico	5,500	123
North Carolina	85,707	737
South Dakota and Wyoming	1,250	480
Total	108,570	1,505

IMPORTS.

The following table shows the imports of unmanufactured mica from 1869 to 1896:

Unmanufactured mica imported and entered for consumption in the United States, 1869 to 1896, inclusive.

Year ending—	Value.	Year ending—	Value.
June 30, 1869	$1,165	June 30, 1883	$9,884
1870	226	1884	28,284
1871	1,460	1885	28,685
1872	1,002	Dec. 31, 1886	*a* 56,354
1873	498	1887	*a* 49,085
1874	1,204	1888	*a* 57,541
1875		1889	*a* 97,351
1876	569	1890	*a* 207,375
1877	13,085	1891	95,242
1878	7,930	1892	218,938
1879	9,274	1893	147,927
1880	12,562	1894	126,184
1881	5,839	1895	174,886
1882	5,175	1896	169,085

a Including mica waste.

Under the new classification, made necessary by the Dingley tariff bill, in effect from and after July 24, 1897, mica is designated as "unmanufactured" and "cut or trimmed." A specific import duty of 6 cents per pound is imposed upon the former and 12 cents per pound upon the latter, with an additional 20 per cent ad valorem duty upon

each. The imports during 1897, before and after the new classification took effect, and for the years 1898 and 1899 were as follows:

Mica imported and entered for consumption in 1897, 1898, and 1899.

Year.	Quantity.	Value.
1897.	*Pounds.*	
Prior to July 24	656,118	$140,353
After July 24:		
Unmanufactured	66,821	10,981
Cut or trimmed	226,771	41,068
Total	949,710	192,402
1898.		
Unmanufactured	877,930	115,930
Cut or trimmed	78,567	34,152
Total	956,497	150,082
1899.		
Unmanufactured	1,709,839	233,446
Cut or trimmed	67,293	42,538
Total	1,777,132	275,984

FLUORSPAR.

By Edward W. Parker.

PRODUCTION.

The production of fluorspar in 1899 amounted to 15,900 short tons, having a total value at the mines of $96,650. This product exceeded both in quantity and value the output of any previous year. Compared with the product of 1898, there was an increase of over 100 per cent in the amount of fluorspar produced, while the value increased about 55 per cent. Nearly 80 per cent of the product in 1899 was from the recently developed localities in Caldwell, Crittenden, and Livingston counties, Kentucky, the remainder being contributed by the old mines near Rosiclare, Illinois.

The larger part of the fluorspar product is sold without further preparation than the removal of dirt and such impurities as lead and zinc, with which it is frequently associated. The amount of crude fluorspar sold in 1899 was 12,400 short tons, shipped in bulk, valued at $71,650. The remainder (3,500 short tons) was ground and shipped in barrels, and was valued at $25,000.

In addition to the localities in Illinois and Kentucky, from which the entire product in 1899 was obtained, fluorspar has been reported as occurring in abundance near Castle Dome, in Yuma County, Arizona, and as associated with the telluride ores of Cripple Creek, Colorado.

The following table shows the annual production of fluorspar since 1882:

Production of fluorspar in the United States from 1882 to 1899.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	4,000	$20,000	1891	10,044	$78,330
1883	4,000	20,000	1892	12,250	89,000
1884	4,000	20,000	1893	12,400	84,000
1885	5,000	22,500	1894	7,500	47,500
1886	5,000	22,000	1895	4,000	24,000
1887	5,000	20,000	1896	6,500	52,000
1888	6,000	30,000	1897	5,062	37,159
1889	9,500	45,835	1898	7,675	63,050
1890	8,250	55,328	1899	15,900	96,650

USES.

Fluorspar, or calcium fluoride, is the principal ingredient in the preparation of hydrofluoric acid, which is produced by the distillation of fluorspar with concentrated sulphuric acid, the reaction being—

$$CaF_2+H_2SO_4=2HF+CaSO_4.$$

The mineral is also used to some extent in the manufacture of opalescent glass. It is particularly valuable as a flux in iron smelting, the principal reason assigned for the relatively small amount used being its higher cost when compared with ordinary limestone and the distance of the mines from the large iron-making districts. The fluorspar producers state that the increased production in 1899 was due to the demand for fluxing purposes, the higher prices for finished iron during that year making a greater expense for fluxing material an insignificant factor of cost.

IMPORTS OF CRYOLITE.

The records of the Bureau of Statistics of the Treasury Department do not make any separation of fluorspar imported into the United States; it is included among minerals and ores "not elsewhere specified." Cryolite, however, is imported from Greenland by the Pennsylvania Salt Company for use in the manufacture of sodium and alum salts.

The imports of cryolite for a series of years are shown in the following table:

Imports of cryolite from 1871 to 1899.

Year ending—	Amount.	Value.	Year ending—	Amount.	Value.
	Long tons.			*Long tons.*	
June 30, 1871	....	$71,058	Dec. 31, 1885	8,275	$110,750
1872	....	75,195	1886	8,230	110,152
1873	....	84,226	1887	10,328	138,068
1874	....	28,118	1888	7,388	98,830
1875	....	70,472	1889	8,603	115,158
1876	....	103,530	1890	7,129	95,405
1877	....	126,692	1891	8,298	76,350
1878	....	105,884	1892	7,241	96,932
1879	....	66,042	1893	9,574	126,688
1880	....	91,366	1894	10,684	142,494
1881	....	103,529	1895	9,425	125,368
1882	3,758	51,589	1896	3,009	40,056
1883	6,508	97,400	1897	10,115	135,114
1884	7,390	106,029	1898	6,201	88,501
			1899	5,879	78,676

ASBESTOS.

By Edward W. Parker.

PRODUCTION.

Asbestos mining in the United States during 1899 was confined to the two States which have supplied all of the domestic material for several years—California and Georgia. All but a small percentage of the total was from the mines of the Sall Mountain Asbestos Company, White County, Georgia. The total product in 1899 amounted to 681 short tons, worth, crude, at the mines $11,740, an increase from a product of 605 tons, worth $10,300, in 1898, and with one exception the largest output both in amount and value within the last fifteen years.

When considered in connection with our importations and the magnitude of the establishments engaged in the manufacture of asbestos products, the domestic production of crude asbestos falls into insignificance. During the last decade and a half the total value of our domestic production has not reached $15,000 in any one year, and has averaged less than half that amount, while the imports, chiefly from Black Lake and Thetford, in Canada, have averaged $231,823 in the same period. In the last ten years the value of the imported material has averaged nearly $270,000. The use of asbestos in any great quantity has been the development of the last fifteen years. During the five years prior to 1885 our imports averaged $25,563; from 1875 to 1879, inclusive, the average was $5,324, while in the six years from 1869 to 1874, inclusive, the average was only $83.

It is probably well to repeat here the statement made in previous reports, in regard to the two distinct minerals which are treated in this report under the same name. True asbestos is a silicate of calcium and magnesium, and usually occurs associated with soapstone. A very similar mineral in appearance, and possessing equal heat-resisting qualities is chrysotile, a fibrous variety of serpentine, which is a hydrous silicate of magnesium, and occurs in well-defined veins penetrating serpentine rock. The latter is superior in strength and elasticity of fiber to any true asbestos found in the United States, which recommends it for use in the manufacture of fireproof textiles. It is known commercially as

asbestos, and is so considered in these reports. Practically all of this material comes from Canada. The domestic product is esteemed as an ingredient in fireproof paints, for "packing" in the manufacture of fireproof safes, for boiler covering, wall plasters, and other purposes where strength of fiber is not essential, and where nonconductivity of heat is a prime factor.

The McConnell Asbestos Company, which has acquired interests in the asbestos (or chrysotile) deposits near Casper, Wyoming, reports that a considerable amount of development work was done in 1899 in the way of tunnel driving, etc., and the company hopes and expects to be actively mining before the close of 1900.

The richness and proximity of the Canadian chrysotile deposits, added to the superior quality of the fiber, have been potential factors against the successful operations of our Eastern deposits, while the long distance from the manufacturing centers, and the consequent expensive freight costs, have militated against the more rapid development of the Western localities.

The following table exhibits the annual production of asbestos in the United States since 1880, with the value:

Annual product of asbestos since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	150	$4,312	1890	71	$4,560
1881	200	7,000	1891	66	3,960
1882	1,200	36,000	1892	104	6,416
1883	1,000	30,000	1893	50	2,500
1884	1,000	30,000	1894	325	4,463
1885	300	9,000	1895	795	13,525
1886	200	6,000	1896	504	6,100
1887	150	4,500	1897	580	6,450
1888	100	3,000	1898	605	10,300
1889	30	1,800	1899	681	11,740

Comparing the above table with that of the table of imports, which is given below, it will be seen that there is a profitable market to be supplied with domestic fiber, if any be found which is equal in quality to that of the Canadian chrysotile, nearly all of the imports into the United States being from the Canadian mines.

IMPORTS.

The following table shows the value of asbestos imported since 1869:

Value of asbestos imported since 1869.

Year ending—	Unmanufactured.	Manufactured.	Total.
June 30, 1869		$310	$310
1870		7	7
1871		12	12
1872			
1873	$18		18
1874	152		152
1875	4,706	1,077	5,783
1876	5,485	396	5,881
1877	1,671	1,550	3,221
1878	3,536	372	3,908
1879	3,204	4,624	7,828
1880	9,736		9,736
1881	27,717	69	27,786
1882	15,235	504	15,739
1883	24,369	243	24,612
1884	48,755	1,185	49,940
Dec. 31, 1885	73,026	617	73,643
1886	134,193	932	135,125
1887	140,264	581	140,845
1888	168,584	8,126	176,710
1889	254,239	9,154	263,393
1890	252,557	5,342	257,899
1891	353,589	4,872	358,461
1892	262,433	7,209	269,642
1893	175,602	9,403	185,005
1894	240,029	15,989	256,018
1895	225,147	19,731	244,878
1896	229,084	5,773	234,857
1897	263,640	4,624	268,264
1898	287,636	12,897	300,533
1899	303,119	8,949	312,068

CANADIAN PRODUCTION.

As the supply of asbestos for the United States is drawn almost entirely from Canada, the following table of production for that country will be found of interest:

Annual product of asbestos in Canada since 1879.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1879	300	$19,500	1890	9,860	$1,260,240
1880	380	24,700	1891	9,279	999,978
1881	540	35,100	1892	6,042	388,462
1882	810	52,650	1893	6,473	313,806
1883	955	68,750	1894	7,630	420,825
1884	1,141	75,079	1895	8,756	368,175
1885	2,440	142,441	1896	12,250	429,856
1886	3,458	206,251	1897	[a]30,442	445,368
1887	4,619	226,976	1898	[a]23,785	486,227
1888	4,404	255,007	1899	[a]25,536	485,849
1889	6,113	426,554			

[a] Including asbestic.

The increased production of nearly 150 per cent in 1897, accompanied by an increase of less than 4 per cent in value, was due to the large amount of asbestic and low grade of fiber included in the product. Conversely, the increase of 9.17 per cent in value in 1898, with a decrease of nearly 22 per cent in the product was due to a smaller proportion of asbestic. In the foregoing statement the figures for 1899 are taken from the advance summary of production, published by the geological survey of Canada, in which the production of asbestos and asbestic is not stated separately. The annual report for 1897 gives the production of asbestos in 1896 at 10,892 tons, valued at $423,066, and that of asbestic 1,538 tons, worth $6,790. In 1897 the asbestos product was 13,202 tons, worth $399,528, and that of asbestic 17,240 tons, valued at $45,840. It will be seen from this that while there was a decline in the price per ton of both asbestos and asbestic in 1897 as compared with 1896, the greater portion of the disparity in the product and value in the two years was due to the larger percentage of asbestic in the total. In the reports of production in 1898 and 1899 the amount of asbestic included in the product is not stated. The larger output in 1899, combined with a decrease in value, indicates a smaller proportion of asbestos and a larger yield in asbestic.

GRAPHITE.

PRODUCTION.

Graphite production in 1899 was limited to the same five States from which the product in 1898 was obtained—Alabama, Michigan, New York, Pennsylvania, and Rhode Island. The marketed product consisted of 2,900,782 pounds of refined crystalline graphite and 2,324 short tons of amorphous graphite, having an aggregate value of $167,106. The amount of refined graphite produced in 1899 was not quite 25 per cent more than that of 1898. The amount of amorphous material produced was nearly three times that of the preceding year. The total value was more than double that of 1898 and more than $55,000, or 50 per cent more than the highest value previously reported—that of 1891. The largest part of the crystalline product was, as usual, from Ticonderoga, New York; smaller quantities were produced in Chester County, Pennsylvania, and Clay County, Alabama. The amorphous product was from Rhode Island and Baraga County, Michigan.

The following table shows the annual production of graphite since 1880:

Production of graphite since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880..pounds.	622,500	$49,800	1893..pounds..	843,103	$63,232
1881.... do...	400,000	30,000	1894..... do...	918,000	64,010
1882.... do...	425,000	34,000	1895 ---- do...	644,700	52,582
1883.... do...	575,000	46,000	1895 short tons	2,793	
1884.... do...	500,000	35,000	1896 pounds...	535,858	48,460
1885.... do...	327,883	26,231	1896 short tons	760	
1886.... do...	415,525	33,242	1897 pounds...	1,361,706	65,730
1887.... do...	416,000	34,000	1897 short tons	1,070	
1888.... do...	400,000	33,000	1898 pounds...	2,360,000	75,200
1889..........	....	72,662	1898 short tons	890	
1890..........	....	77,500	1899 pounds...	2,900,732	167,106
1891..pounds.	1,559,674	110,000	1899 short tons	2,324	
1892.... do...	1,398,365	87,902			

ARTIFICIAL GRAPHITE.

During 1899 the Acheson Graphite Company, of Niagara Falls, New York, produced 405,870 pounds of graphitized carbons in the shape of anodes and electrodes for use in the manufacture of alkalies and bleaching powder by electrolysis, for the electric reduction of zinc and other metals, and for use as motor brushes. The material has a selling value of about 8 cents per pound in the finished forms. In December, 1899, the company was engaged in the erection of a plant for the manufacture of flake and powdered graphite in bulk. The plant is to have a capacity of five tons per day. About 10,000 pounds of this graphite was produced experimentally. The ability to produce this artificial graphite has been one of the developments of the manufacture of carborundum, and the foregoing information has been furnished by Mr. E. G. Acheson, president of the Acheson Graphite Company, and also president of the Carborundum Company. The manufactured product is not included in the statistics of the production of graphite.

IMPORTS.

The following table, showing the amount and value of the graphite imported into the United States, indicates that a comparatively small portion of the consumption is supplied by the domestic product. The imports in 1899 exceeded those of 1898 by more than 50 per cent in quantity, while the value was greater than that of the five previous years combined. The principal portion of the graphite imported into the United States is from the island of Ceylon, where the production in 1899 was the largest ever made. The value of the graphite imported into the United States in 1899 was twelve times the value of the domestic product, notwithstanding the increased production in this country. In 1898 the value of the imports was ten times that of the domestic product, and in 1897 it was only a little more than four times as much.

Graphite imported into the United States since 1867.

Year ending—	Unmanufactured.		Manufactured.	Total.
	Quantity.	Value.	Value.	Value.
	Cwt.			
June 30, 1867	27,113	$54,131	....	$54,131
1868	68,620	149,083	....	149,083
1869	74,846	351,004	....	351,004
1870	80,795	269,291	$833	270,124
1871	51,628	136,200	3,754	139,954
1872	96,381	329,030	....	329,030
1873	157,539	548,613	....	548,613
1874	111,992	382,591	....	382,591
1875	46,492	122,050	....	122,050
1876	50,589	150,709	17,605	168,314
1877	75,361	204,630	18,091	222,721
1878	60,244	154,757	16,909	171,666
1879	65,662	164,013	24,637	188,650
1880	109,908	278,022	22,941	300,963
1881	150,927	381,966	31,674	413,640
1882	150,421	363,835	25,536	389,371
1883	154,893	361,949	21,721	383,670
1884	144,086	286,393	1,863	288,256
1885	110,462	207,228	....	207,228
1886	83,368	164,111	....	164,111
1887	168,841	331,621	....	331,621
Dec. 31, 1888	184,013	353,990	....	353,990
1889	177,381	378,057	....	378,057
1890	255,955	594,746	....	594,746
1891	212,360	555,080	....	555,080
1892	233,540	667,775	....	667,775
1893	288,740	865,379	....	865,379
1894	*a* 5,814	225,720	....	225,720
1895	8,814	260,090	....	260,090
1896	15,230	437,159	....	437,159
1897	8,533	270,952	....	270,952
1898	13,482	743,820	....	743,820
1899	20,793	1,990,649	....	1,990,649

a Long tons since 1894.

CANADIAN PRODUCTION.

The Geological Survey of Canada in its report for 1897 gives the production of graphite in Canada for a series of years. The great variations exhibited in the average price are attributed to the varying quantities of different qualities produced in different years, and these can not be separated on account of the confidential nature of the producers' returns.

The amount and value of the product in 1899 were the largest in fourteen years; but the industry at best is a small one.

Annual product of graphite in Canada since 1886.

Calendar year.	Tons.	Value.
1886	500	$4,000
1887	300	2,400
1888	150	1,200
1889	242	3,160
1890	175	5,200
1891	260	1,560
1892	167	3,763
1893	*None.*	*None.*
1894 (*a*)	69	223
1895	220	6,150
1896	139	9,455
1897	436	16,240
1898	(*b*)	11,098
1899	1,310	24,179

a Exports. *b* Quantity not reported.

MINERAL PAINTS.

By Edward W. Parker.

MINERALS USED AS PIGMENTS.

The mineral substances included under this heading are those which are mined and prepared primarily as pigments. They consist of iron ores (usually hematites) which are ground and used in the manufacture of red and brown pigments, and which are not included in the production of iron ores for iron making; clay and other earths containing iron, used in making yellow and brown pigments, such as ocher, umber, sienna, etc.; barytes (barium sulphate) or "heavy spar," used as a substitute for, or an adulterant of, white lead; slate, or shale; soapstone; asbestos; graphite; and a pure form of gypsum producing terra alba. All of these pigments are made directly from the crude minerals and may be considered natural pigments. It is not always possible, however, to segregate the amount of soapstone, asbestos, and graphite which goes into paint, and reports of the mineral-paint product are therefore partially included in the papers relating to those materials. Venetian red, obtained from iron sulphate by roasting, is also included among the mineral paints, as the amount of iron so consumed is so small when compared with the iron product that it would not affect the total. Zinc white is produced directly from the ores and properly belongs in the product of pigments.

To the above should be added the preparations made from pig lead, namely, white lead, red lead, litharge, and orange mineral; also vermilion, made from quicksilver; chrome yellow, made from potassium bichromate; blanc fixe, made by treating barium carbonate with sulphuric acid and precipitating artificial barytes. The bases from which these pigments are obtained are included in the production of pig lead, quicksilver, chromium, etc., and the pigments themselves, being the results of chemical decomposition and combination, are not grouped among the "mineral paints," although the statistics of white lead, etc., are treated in this chapter. It has also been customary to treat barytes separately. This custom is adhered to in this report.

PRODUCTION.

As previously stated and as shown in the following table, the pigments treated in this report as mineral paints consist of metallic paint, mortar colors, ocher, umber, sienna, venetian reds, zinc white, and slate and soapstone ground specially for paint. The production in the past three years includes also graphitic shale mined in Georgia and used as a coloring material in fertilizers.

The combined product of these pigments in 1899 amounted to 103,257 short tons as compared with 91,850 tons in 1898. The value of the product increased nearly $1,000,000—from $3,004,856 to $3,940,069. More than half of the total increase in quantity, and nearly all of the increase in value, was in zinc white. Venetian-red production also showed a considerable gain over 1898 (1,720 tons in amount and $49,650 in value), and ocher production gained in both tonnage and value, but the increase in value was in considerably less proportion than the increase in product. These increases in value were partly offset by losses in metallic paint (notwithstanding increased tonnage), mortar colors, umber, sienna, and slate.

The production of metallic paint increased from 20,972 short tons to 23,423 short tons, but the value fell off from $263,979 to $249,945. Mortar colors decreased from 7,107 short tons, valued at $74,894, to 5,736 short tons, worth $65,156—a loss of 1,371 tons and $9,738. Ocher, umber, and sienna combined increased from 13,829 tons, worth $143,257, to 15,185 tons, valued at $152,524—a gain of 10 per cent in amount but of only 6.5 per cent in value.

It may be well to state that in considering the variations between product and value allowance must be made for the comparatively wide range in the qualities of the materials and the fact that a larger production of a higher or lower priced article will effect a comparatively larger or smaller increase in the value, as the case may be, and that the rise or fall shown in the average price may be apparent only. Zinc white and venetian red are practically uniform in quality, but the same does not hold with the other pigments. It is evident that the decline in value of metallic paint, notwithstanding an increased tonnage, was due to the displacement in the market of some higher-priced paint by a cheaper article.

The production of mineral paints for the last seven years has been as follows:

Production of mineral paints since 1893.

Kind.	1893.		1894.		1895.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Ocher	10,517	$129,393	9,768	$96,935	12,045	$139,328
Umber	480	7,560	265	3,830	320	4,350
Sienna	150	4,875	160	3,250	275	6,950
Metallic paint / Mortar color	19,960	297,289				
Metallic paint			15,225	189,922	17,315	212,761
Mortar color			10,150	94,961	11,544	106,381
Venetian red	3,214	64,400	2,983	73,300	4,595	102,900
Zinc white	24,059	1,804,420	19,987	1,399,090	20,710	1,449,700
Soapstone	100	700	75	525	270	3,200
Slate [a]	3,253	25,567	3,300	35,370	4,331	45,682
Other colors	50	600				
Total	61,783	2,334,804	61,913	1,897,183	71,405	2,071,252

Kind.	1896.		1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Ocher	14,074	$136,458	14,006	$162,764	11,963	$123,832	14,124	$140,168
Umber	165	2,646	[b] 1,080	11,710	[c] 1,177	8,285	473	4,151
Sienna	395	5,416	620	10,610	689	11,140	588	8,205
Metallic paint	14,805	180,134	16,699	187,694	20,972	263,979	23,423	249,945
Mortar color	9,660	89,600	8,237	75,570	7,107	74,894	5,736	65,156
Venetian red	4,138	93,866	13,603	294,744	10,271	160,711	11,991	210,361
Zinc white	20,000	1,400,000	25,000	1,750,000	33,000	2,310,000	40,146	3,211,680
Soapstone			2	20	100	800	100	700
Slate [a]	4,795	44,835	4,666	46,681	4,571	46,215	4,676	43,703
Other colors			[d] 2,000	6,000	[d] 2,000	6,000	[d] 2,000	6,000
Total	68,032	1,952,955	85,913	2,545,793	91,850	3,004,856	103,257	3,940,069

[a] Including mineral black.
[b] Includes 600 tons of "Spanish brown."
[c] Includes 640 tons "Spanish brown."
[d] Graphitic shale.

OCHER, UMBER, AND SIENNA.

Ocher is an impure hydrated oxide of iron or silicate of alumina colored by iron. Its color is usually yellow, but is sometimes red or brown. The common form of ocher used commercially as a pigment is yellow in color, but of a great variety of shades, beauty, and opacity. Umber and sienna differ in composition from ocher in that manganese is present in addition to oxide of iron. Raw umber is used by painters as a brown color. Burnt umber is of somewhat richer and redder tinge than the raw, and is very popular. Sienna may be said to come between the other two. Used raw it is of a brownish-yellow hue. When burnt

a redder tinge is developed, which makes a pigment of a rich russet brown.

These pigments are notable not only for their stability of color, but because they may be used with either oil or water as a vehicle for painting, in frescoing, and in the manufacture of wall paper and other colored papers.

PRODUCTION.

Ocher was produced in thirteen States during 1899, viz: Alabama, Arkansas, California, Georgia, Iowa, Maryland, Massachusetts, Missouri, New York, Pennsylvania, Texas, Vermont, and Virginia. The number of producing States is the same as in 1898, but there are four changes. Illinois and Mississippi, which were among the producers in 1898, reported no product in 1899, and Arkansas and Texas added a small portion to the product last year, and none in 1898. In each of the thirteen States, excepting Georgia, Pennsylvania, and Vermont, there were only one or two producers, and the output of the other ten States is combined in order not to divulge individual statistics. The three states mentioned produced in 1899 nearly four times the output of the other ten States. Pennsylvania alone produced over one-half the entire output. Kansas, which was credited with a small production in 1897, did not produce any ocher in 1898 or 1899. Illinois and Mississippi each produced a small amount (3 tons) in 1898, no output having been previously reported from either.

Umber and sienna were produced in three States—New York, Pennsylvania, and Missouri, Pennsylvania producing more than nine-tenths of the former and more than one-half of the latter.

The following tables show the production of ocher, umber, and sienna during 1896, 1897, 1898, and 1899. As previously stated, the variations in value are due chiefly to increased or decreased production of different grades of ocher, not to fluctuations in prices:

Production of ocher in 1896, 1897, 1898, and 1899, by States.

State.	1896.		1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Georgia	2,981	$28,005	2,608	$36,600	2,858	$30,798	3,212	$39,505
Pennsylvania	2,926	26,818	6,825	81,325	5,986	61,500	7,285	57,245
Vermont	....	....	693	7,739	664	6,650	653	6,200
Other States	8,167	81,635	3,880	37,100	2,455	24,884	2,974	37,218
Total	14,074	136,458	14,006	162,764	11,963	123,832	14,124	140,168

Production of umber and sienna in 1896, 1897, 1898, and 1899.

Year.	Umber.		Sienna.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1896	165	$2,646	395	$5,416
1897	*a* 1,080	11,710	620	10,610
1898	*b* 1,177	8,285	689	11,140
1899	473	4,151	588	8,205

a Includes 600 tons "Spanish brown" from Maryland.
b Includes 640 tons "Spanish brown" from Maryland.

For purposes of comparison the production for the last ten years is shown in the following table. Prior to 1889, when the statistics were compiled for the Eleventh Census, the production for each State was not published.

Production of ocher, umber, and sienna from 1889 to 1899, by States.

State.	1889.		1890.		1891.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	336	$3,500	350	$4,100	524	$5,840
Colorado	50	150	1,000	15,000		
Georgia	2,512	29,720	800	12,800	600	9,000
Maryland	616	12,000				
Massachusetts	80	750	300	2,700	300	2,700
Missouri			2,200	30,000	1,850	27,500
New Jersey					600	7,200
New York			365	4,493		
Pennsylvania	7,922	103,797	4,173	61,458	4,535	56,588
Vermont	1,884	7,800			935	11,095
Virginia	1,658	18,755	1,367	22,972	1,950	29,900
Wisconsin	100	1,000				
Other States			*a* 7,000	84,000	*a* 7,000	84,000
Total	15,158	177,472	17,555	237,523	18,294	233,823

a Includes all of Maryland and estimated product of some firms in other States not reporting.

Production of ocher, umber, and sienna from 1889 to 1899, by States—Continued.

State.	1892.		1893.		1894.		1895.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Alabama	375	$4,050	350	$3,000	......	....	......	....
Georgia	1,748	26,800	2,600	39,000	1,690	$17,840	2,105	$31,080
Maryland	1,000	10,000	......	....	......	....	......	....
Massachusetts	46	418	......	....	......	....	......	....
Missouri	1,922	28,220	555	5,413	1,800	23,160	......	....
New Jersey	175	3,600	......	....	......	....	......	....
Pennsylvania	7,055	90,755	5,375	71,575	4,975	47,830	*c*7,395	85,600
Vermont	544	5,731	523	5,280	336	3,384	......	....
Virginia	1,500	23,500	......	....	......	....	......	....
Other States	......	....	*a*1,744	17,560	*b*1,392	11,801	*d*3,140	33,948
Total	14,365	193,074	11,147	141,828	10,193	104,015	12,640	150,628

State.	1896.		1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Georgia	2,981	$28,005	2,608	$36,600	2,858	$30,798	3,212	$39,505
Pennsylvania	*c*3,486	34,880	7,595	95,245	6,953	73,245	8,118	65,990
Vermont	......	....	693	7,739	664	6,650	653	6,200
Other States *d*	8,167	81,635	4,810	45,500	3,354	32,564	3,202	40,829
Total	14,634	144,520	15,706	185,084	13,829	143,257	15,185	152,524

a Includes Kentucky, Maryland, Massachusetts, and Virginia.
b Includes Alabama, Kentucky, Maryland, Massachusetts, Virginia, and Wisconsin.
c Includes Missouri and New York's product of umber and sienna.
d Includes Alabama, Arkansas, California, Illinois, Iowa, Kansas, Maryland, Mississippi, Missouri, New York, Texas, Vermont, Virginia, and Wisconsin.

Annual production of ocher, etc., since 1884.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1884	7,000	$84,000	1892	14,365	$193,074
1885	3,950	43,575	1893	11,147	141,828
1886	6,300	91,850	1894	10,193	104,015
1887	8,000	75,000	1895	12,640	150,628
1888	10,000	120,000	1896	14,634	144,520
1889	15,158	177,472	1897	15,706	185,084
1890	17,555	237,523	1898	13,829	143,257
1891	18,294	233,823	1899	15,185	152,524

IMPORTS.

The following tables show the amount and value of ochers, etc., imported into the United States from 1867 to 1899:

Ocher, etc., imported from 1867 to 1883.

Fiscal year ending June 30—	All ground in oil.		Indian red and Spanish brown.		Mineral French, and paris green.		Other, dry, not otherwise specified.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1867	11,373	$385		$35,374		$2,083	1,430,118	$9,923
1868	6,949	333		11,165		500	3,670,093	32,102
1869	65,344	2,496	2,582,335	31,624	8,369	2,495	5,379,478	39,546
1870	149,240	6,042	3,377,944	41,607	9,618	3,444	3,935,978	32,593
1871	121,080	4,465	2,286,930	40,663	33,488	11,038	2,800,148	24,767
1872	277,617	9,225	2,810,282	38,763	41,422	10,341	5,645,343	56,680
1873	94,245	3,850	135,360	2,506	34,382	8,078	3,940,785	51,318
1874	98,176	4,623	263,389	3,772	102,876	18,153	3,212,988	35,365
1875	280,517	12,352	646,009	9,714	64,910	13,506	3,282,415	37,929
1876	63,916	3,365	2,524,989	19,555	21,222	5,385	3,962,646	47,405
1877	41,718	2,269	2,179,631	24,218	27,687	6,724	3,427,208	32,924
1878	25,674	1,591	2,314,028	23,677	67,655	14,376	3,910,947	33,260
1879	17,649	1,141	2,873,550	26,929	17,598	3,114	3,792,850	42,563
1880	91,293	4,233	3,655,920	32,726	16,154	3,269	4,602,546	52,120
1881	99,431	4,676	3,201,880	30,195	75,465	14,648	3,414,704	46,069
1882	159,281	7,915	3,789,586	34,136	18,293	2,821	5,530,204	68,106
1883 *a*	137,978	6,143	1,549,968	13,788	6,972	885	7,022,615	90,593

a Since 1883 classified as "dry" and "ground in oil."

Imports of ocher of all kinds from 1884 to 1899.

Year ending—	Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
June 30, 1884..	6, 164, 359	$63, 973	108, 966	$4, 717	6, 273, 325	$68, 690
1885..	4, 983, 701	51, 499	79, 666	3, 616	5, 063, 363	55, 115
Dec. 31, 1886..	4, 939, 183	53, 593	112, 784	6, 574	5, 051, 967	60, 167
1887..	5, 957, 200	58, 162	54, 104	7, 337	6, 011, 304	65, 499
1888..	6, 574, 608	64, 123	43, 142	9, 690	6, 617, 750	73, 813
1889..	5, 540, 267	52, 502	51, 063	9, 072	5, 591, 330	61, 574
1890..	....	....	....	....	6, 471, 863	71, 953
1891..	6, 246, 890	63, 040	52, 206	5, 272	6, 299, 096	68, 312
1892..	8, 044, 836	97, 946	49, 714	5, 120	8, 094, 550	103, 066
1893..	6, 225, 789	55, 074	52, 468	3, 354	6, 278, 257	58, 428
1894..	4, 937, 738	45, 276	22, 387	2, 100	4, 960, 125	47, 376
1895..	7, 107, 987	56, 020	41, 153	2, 239	7, 149, 140	58, 259
1896..	8, 954, 252	68, 196	27, 023	1, 561	8, 981, 275	69, 757
1897..	*a* 7, 720, 075	59, 272	20, 123	1, 000	7, 740, 198	60, 272
1898..	5, 898, 725	46, 571	31, 460	1, 546	5, 930, 185	48, 117
1899..	9, 765, 616	72, 825	14, 881	756	9, 780, 497	73, 581

a Since 1896 classified as "dry—crude and powdered, washed or pulverized."

Imports of umber from 1867 to 1899.

Year ending—	Quantity.	Value.	Year ending—	Quantity.	Value.
	Pounds.			*Pounds.*	
June 30, 1867..	2,147,342	$15,946	June 30, 1884..	2,946,675	$20,654
1868..	345,173	2,750	1885..	1,198,060	8,504
1869..	570,771	6,159	Dec. 31, 1886..	1,262,930	9,187
1870..	708,825	6,313	1887..	2,385,281	16,536
1871..	470,392	7,064	1888..	1,423,800	14,684
1872..	1,409,822	18,203	1889..	1,555,070	20,887
1873..	845,601	8,414	1890..	1,556,823	19,329
1874..	729,864	6,200	1891..	633,291	6,498
1875..	513,811	5,596	1892..	1,028,038	6,256
1876..	681,199	7,527	1893..	1,488,849	16,636
1877..	1,101,422	10,213	1894..	632,995	6,275
1878..	1,038,880	8,302	1895..	*a* 1,560,786	13,075
1879..	986,105	6,959	1896..	*b* 689,075	8,360
1880..	1,877,645	17,271	1897..	*c* 1,447,889	14,479
1881..	1,475,835	11,126	1898..	*d* 1,123,079	9,051
1882..	1,923,648	20,494	1899..	*e* 1,739,036	13,326
1883..	785,794	8,419			

a Includes 6,137 pounds ground in oil and 1,554,649 pounds dry.
b Includes 5,292 pounds ground in oil and 683,783 pounds dry.
c Includes 14,471 pounds ground in oil and 1,433,418 pounds "dry—crude and powdered."
d Includes 4,608 pounds ground in oil and 1,118,471 pounds "dry—crude and powdered, washed or pulverized."
e Includes 4,849 pounds ground in oil and 1,734,187 pounds "dry—crude and powdered, washed or pulverized.

Imports of sienna since 1893.

Year ending—	Dry.		Ground in oil.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Dec. 31, 1893	1,626,536	$138,889	5,857	$610
1894	337,909	9,424	18,877	895
1895	456,861	11,021	6,576	501
1896	668,461	10,857	10,848	877
1897	580,468	12,340	7,058	481
1898	544,713	11,451	4,008	280
1899	798,691	14,470	6,484	492

The following table indicates the output of ocher in some of the principal producing countries for years for which comparable statistics are available. France leads in amount, with the United States second,

until 1897, when Great Britain's product exceeded that of the United States. In the value of the product the United States stands first, France second, and Great Britain third. The German Empire stands fourth both in amount and value of the product.

Production of ocher in principal producing countries from 1893 to 1898.

Year.	United States.		United Kingdom.		France.		German Empire.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
1893..	11,147	$141,828	11,798	$67,318	....	....	....	....
1894..	10,193	104,015	9,538	68,094	....	....	....	....
1895..	12,640	150,628	8,540	82,397	36,456	$142,756	9,911	$25,297
1896..	14,634	144,520	11,078	99,737	30,304	125,164	9,918	26,227
1897..	15,706	185,084	16,153	63,165	35,594	150,714	9,660	25,242
1898..	13,829	143,257	22,206	63,065	37,236	152,002	9,642	31,737

Year.	Canada.		Belgium.		Spain.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
1893..	1,070	$17,710	1,408	$1,351	1,135	$685	....	....
1894..	611	8,690	400	965	132	232	1,714	$3,822
1895..	1,339	14,600	800	1,930	224	760	1,500	3,293
1896..	2,362	16,045	1,120	2,702	234	820	3,240	6,955
1897..	3,905	23,560	560	1,400	220	772	1,721	3,776
1898..	2,340	18,531	....	....	220	800	3,206	4,656

METALLIC PAINT.

Metallic paint is obtained by grinding certain qualities of hematite iron ore. Some of the ores are roasted before grinding in order to improve their color and durability. Considering the profusion of iron ore which exists in the United States, the amount of material suitable for making a good quality of metallic paint is small and the localities comparatively rare. Among the localities from which good paint ore is to be obtained are Oneida, Rensselaer, Cattaraugus, and Washington counties, New York; Lehigh, Carbon, and Mercer counties, Pennsylvania; Hamilton and James counties, Tennessee, and Dodge County, Wisconsin. It is also produced in smaller quantities in Maryland, Arkansas, California, Illinois, Iowa, Vermont, Missouri, Ohio, and Wyoming. Part of the ore ground for paint is used as a coloring matter in mortar making. It is not always possible to separate exactly

the amount used for mortar colors, as the manufacturers, having sold it as dry ground paint, do not always know how it is consumed after leaving their hands. The separation given in this report is the best that could be made. It is not claimed that it is absolutely correct.

The production of metallic paint in 1899 (exclusive of mortar colors) amounted to 23,423 short tons, valued at $249,945. As compared with 1898 this shows an increase of 2,451 short tons in quantity and a loss of $14,034 in value. While there was probably a slight falling off in values in 1899 the large decrease in value, when accompanied by such a substantial increase in product, is more to be attributed to an increased production of cheaper paint and a falling off in the output of high-priced grades.

The production of mortar colors decreased from 7,107 short tons in 1898 to 5,736 tons in 1899. The value fell off from $74,894 to $65,156. In the following table is shown the production of metallic paint and mortar colors in 1898, distributed by States, when it is possible to do so without divulging individual reports:

Production of metallic paint and mortar colors in 1898 and 1899.

State.	1898.			
	Metallic paint.		Mortar colors.	
	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*	
New York	3,600	$45,000	4,050	$44,000
Pennsylvania	8,379	139,392	900	8,000
Other States	8,993	79,587	2,157	22,894
Total	20,972	263,979	7,107	74,894

State.	1899.			
	Metallic paint.		Mortar colors.	
	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*	
New York	4,938	$46,994	1,450	$14,000
Pennsylvania	9,062	128,734	1,500	18,010
Tennessee	5,983	40,050	1,022	11,242
Other States	3,440	34,167	1,764	21,904
Total	23,423	249,945	5,736	65,156

The annual product for the past eleven years has been as follows:

Production of metallic paint and mortar colors since 1889.

Year.	Metallic paint. (*a*)		Mortar colors.	
	Short tons.	Value.	Short tons.	Value.
1889	21,026	$286,294		
1890	24,177	340,369		
1891	25,142	334,455		
1892	25,711	362,966		
1893	19,960	297,289		
1894	15,225	189,922	10,150	$94,961
1895	17,315	212,761	11,544	106,381
1896	14,805	180,134	9,660	89,600
1897	16,699	187,694	8,237	75,570
1898	20,972	263,979	7,107	74,894
1899	23,423	249,945	5,736	65,156

a Includes mortar colors from 1889 to 1893, inclusive.

VENETIAN RED.

Venetian red is a bright red pigment obtained by roasting iron sulphate or green vitriol. The sulphur is driven off, leaving iron oxide of a brighter red than that found native. The amount of iron so consumed is comparatively small when considered with the total iron product, and the venetian-red product is accordingly included in the output of mineral paints.

The production of venetian red in 1899 was 11,991 short tons, an increase of 1,720 tons over 1898, and less by 1,612 tons than the abnormally large product of 1897. The value of the product in 1899 was $210,361, a gain of nearly $50,000 over 1898.

The annual production since 1890 has been as follows:

Production of venetian red since 1890.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1890	4,000	$84,100	1895	4,595	$102,900
1891	4,191	90,000	1896	4,138	93,866
1892	4,900	106,800	1897	13,603	294,744
1893	3,214	64,400	1898	10,271	160,711
1894	2,983	73,300	1899	11,991	210,361

SLATE GROUND FOR PIGMENT.

Including "mineral black," a pigment made from the slate partings and roofs in anthracite collieries, the amount of slate and shale ground

for paint in 1899 amounted to 4,676 short tons, valued at $43,673, indicating a gain in amount of 105 tons over 1898, and a loss in value of $2,512.

The annual product of pigments made from slate and shale since 1880 has been as follows:

Amount and value of slate and shale ground for pigment since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	1, 120	$10, 000	1890	2, 240	$20, 000
1881	1, 120	10, 000	1891	2, 240	20, 000
1882	2, 240	24, 000	1892	3, 787	23, 523
1883	2, 240	24, 000	1893	3, 253	25, 567
1884	2, 240	20, 000	1894	3, 300	35, 370
1885	2, 212	24, 687	1895	4, 331	45, 682
1886	3, 360	30, 000	1896	4, 795	44, 835
1887	2, 240	20, 000	1897	4, 666	46, 681
1888	2, 800	25, 100	1898	4, 571	46, 215
1889	2, 240	20, 000	1899	4, 676	43, 703

WHITE LEAD, ETC.

The production of all lead pigments showed substantial increases in 1899. The output of white lead in oil increased from 153,036,302 pounds to 170,214,565 pounds; dry white lead increased from 39,058,581 pounds to 50,178,486 pounds. Red lead production rose from 18,435,016 pounds to 22,157,694 pounds; litharge from 18,176,591 pounds to 21,937,704 pounds, and orange mineral from 1,462,715 pounds to 2,024,302 pounds. Values increased in satisfactory proportion. In each case the figures for 1899 were the maximum.

The production of white lead, red lead, litharge, and orange mineral in 1897, 1898, and 1899 was as follows:

Production of white lead, etc., in 1897, 1898, and 1899.

	1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
White lead:	*Pounds.*		*Pounds.*		*Pounds.*	
In oil	157, 596, 111	$8, 299, 883	153, 036, 302	$7, 740, 345	170, 214, 565	$8, 977, 268
Dry	33, 720, 684	1, 376, 932	39, 058, 581	1, 660, 277	50, 178, 486	2, 340, 689
Red lead	15, 317, 199	731, 312	18, 435, 016	917, 521	22, 157, 694	1, 192, 927
Litharge	13, 266, 322	572, 896	18, 176, 591	834, 965	21, 937, 704	1, 159, 698
Orange mineral	901, 560	55, 468	1, 462, 715	97, 873	2, 024, 302	146, 720

The following table exhibits, with quantities expressed in short tons, the annual production of white lead, red lead, etc., for a series of nine

years. Previous to 1894 the values were based on white lead in oil. The statistics for the past six years include the amount of lead sold, dry and in oil, with the value in the condition in which it was sold.

Production of white lead, etc., for nine years.

	1891.		1892.		1893.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
White lead	78,018	$10,454,029	74,485	$8,733,620	72,172	$7,695,130
Red lead	4,607	591,730	6,122	757,787	6,377	732,968
Litharge	5,759	720,925	5,764	611,726	11,757	1,154,819
Orange mineral	330	43,300	395	60,170	217	32,893

	1894.		1895.		1896.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
White lead	76,343	$6,623,071	90,513	$8,723,632	88,608	$8,371,588
Red lead	6,465	623,021	6,756	628,133	5,731	532,060
Litharge	5,652	495,406	6,987	601,267	6,490	539,700
Orange mineral	319	43,517	366	44,749	270	33,132

	1897.		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
White lead	95,658	$9,676,815	96,047	$9,400,622	110,197	$11,317,957
Red lead	7,659	731,312	9,218	917,521	12,079	1,192,927
Litharge	6,633	572,896	9,088	834,965	10,969	1,159,698
Orange mineral	451	55,468	731	97,873	1,012	146,720

The annual production of white lead since 1884 has been as follows:

Production of white lead in the United States since 1884.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1884	65,000	$6,500,000	1892	74,485	$8,733,620
1885	60,000	6,300,000	1893	72,172	7,695,130
1886	60,000	7,200,000	1894	76,343	6,623,071
1887	70,000	7,560,000	1895	90,513	8,723,632
1888	84,000	10,080,000	1896	88,608	8,371,588
1889	80,000	9,600,000	1897	95,658	9,676,815
1890	77,636	9,382,967	1898	96,047	9,400,622
1891	78,018	10,454,029	1899	110,197	11,317,957

IMPORTS.

The following table shows the imports of white lead, red lead, litharge, and orange mineral since 1867:

Red lead, white lead, litharge, and orange mineral imported from 1867 to 1899.

Year ending—	Red lead.		White lead.		Litharge.		Orange mineral.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
June 30, 1867.....	926,843	$53,087	6,636,508	$430,805	230,382	$8,941	....	....
1868.....	1,201,144	76,773	7,533,225	455,698	250,615	12,225	....	....
1869.....	808,686	46,481	8,948,642	515,783	187,333	7,767	....	....
1870.....	1,042,813	54,626	6,228,285	365,706	97,398	4,442	....	....
1871.....	1,295,616	78,410	8,337,842	483,392	70,889	3,870	....	....
1872.....	1,513,794	85,644	7,153,978	431,477	66,544	3,396	....	....
1873.....	1,583,039	99,891	6,331,373	408,986	40,799	2,379	....	....
1874.....	756,644	56,305	4,771,509	323,926	25,687	1,450	....	....
1875.....	1,048,713	73,131	4,354,131	295,642	15,767	950	....	....
1876.....	749,918	54,884	2,546,776	175,776	47,054	2,562	....	....
1877.....	387,260	28,747	2,644,184	174,844	40,331	2,347	....	....
1878.....	170,608	9,364	1,759,608	113,638	28,190	1,499	....	....
1879.....	143,237	7,237	1,274,196	76,061	38,495	1,667	....	....
1880.....	217,033	10,397	1,906,931	107,104	27,389	1,222	....	....
1881.....	212,423	10,009	1,068,030	60,132	63,058	2,568	....	....
1882.....	288,946	12,207	1,161,889	64,493	54,592	2,191	....	....
1883.....	249,145	10,503	1,044,478	58,588	34,850	1,312	....	....
1884.....	265,693	10,589	902,281	67,918	54,183	1,797	....	....
1885.....	216,449	7,641	705,535	40,437	35,283	1,091	....	....
Dec. 31, 1886.....	597,247	23,038	785,554	57,340	51,409	1,831	....	....
1887.....	371,299	16,056	804,320	58,602	35,908	1,302	....	....
1888.....	529,665	23,684	627,900	49,903	62,211	2,248	....	....
1889.....	522,026	24,400	661,694	56,875	41,230	1,412	....	....
1890.....	450,402	20,718	742,196	57,659	48,283	2,146	....	....
1891.....	651,577	23,807	718,228	40,773	94,586	3,108	....	....
1892.....	812,703	28,443	744,838	40,032	56,737	1,811	1,409,601	$64,133
1893.....	854,982	27,349	686,490	34,145	42,582	1,310	1,385,828	61,360
1894.....	947,873	29,064	796,480	40,939	38,595	1,064	1,386,464	58,614
1895.....	1,764,274	53,139	1,897,892	79,887	97,667	2,812	1,689,367	66,492
1896.....	1,543,262	47,450	1,183,538	52,409	51,050	1,615	1,359,651	51,027
1897.....	1,386,070	46,992	1,101,829	48,988	60,984	1,931	1,486,042	67,549
1898.....	682,449	25,780	506,739	24,334	56,417	2,021	795,116	37,745
1899.....	776,197	30,479	583,409	30,212	55,127	3,614	1,141,387	58,142

PRICES.

The following table is of interest, as it shows the average yearly market prices of corroding pig lead and the net price of white lead in oil (both at New York) and the difference between the two since 1874:

Average yearly net prices, at New York, of pig lead and white lead in oil since 1874.

[Per 100 pounds.]

Year.	Pig lead, in New York.	White lead in oil, in New York.	Difference.	Year.	Pig lead, in New York.	White lead in oil, in New York.	Difference.
1874	$6.00	$11.25	$5.25	1887	$4.47	$5.75	$1.28
1875	5.95	10.50	4.55	1888	4.41	5.75	1.34
1876	6.05	10.00	3.95	1889	3.80	6.00	2.20
1877	5.43	9.00	3.57	1890	4.33	6.25	1.92
1878	3.58	7.25	3.67	1891	4.33	6.37	2.04
1879	4.18	7.00	2.82	1892	4.05	6.39	2.34
1880	5.05	7.60	2.55	1893	3.73	6.03	2.30
1881	4.80	7.25	2.45	1894	3.28	5.26	1.98
1882	4.90	7.00	2.10	1895	3.28	5.05	1.77
1883	4.32	6.88	2.56	1896	3.03	4.90	1.87
1884	3.73	5.90	2.17	1897	3.64	5.00	1.36
1885	3.95	6.00	2.05	1898	3.79	5.08	1.29
1886	4.63	6.25	1.62	1899	4.53	5.35	.82

In considering the variations between the value of pig lead and white lead in oil allowance should be made for the fluctuations in the value of linseed oil, which enters largely into the manufacture of lead in oil. The fluctuations in the price of linseed oil in five years have ranged from 30 cents to 59 cents a gallon. The highest price reached for linseed oil was in July, 1895, and the lowest in the early part of 1897. The price of linseed oil at the opening of 1899 was 41 cents per gallon, sold as low as 37 cents in August, and reached the highest point of the year, 50 cents, in December. The fluctuations in the price of linseed oil in six years have been as follows, in cents, per gallon:

Prices of linseed oil at New York since 1894.

Year.	Cents per gallon.	
	Highest.	Lowest.
1894	56	50
1895	59	42
1896	41	31
1897	43	30
1898	46	34
1899	50	37

The proportions of white lead and oil vary according to trade requirements, but on an average 100 pounds of lead in oil contains 91 pounds of lead and 9 pounds of linseed oil.

ZINC WHITE.

The production of zinc white showed a satisfactory increase in amount, accompanied by an improvement in value in greater ratio than the gain in product. The output in 1899 was 40,146 short tons, valued at $3,211,680, a gain as compared with 1898 of 7,146 tons and a little over $900,000 in value.

The production of zinc oxide in the United States is largely controlled by the New Jersey Zinc Company. The franklinite ore from this company's mines is exceptionally well adapted for production of zinc oxide direct from the ore, as it contains no sulphur, lead, or other deleterious volatile ingredients. The company has met with some delay in completing its new and enlarged plant at Palmerton, Pennsylvania, on account of inability to get materials during the "boom" times of 1899. The plant will, however, be in active operation by the end of this year.

The following table shows the production of zinc oxide from 1880 to 1898:

Production of zinc white since 1880.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	10,107	$763,738	1890	....	$1,600,000
1881	10,000	700,000	1891	23,700	1,600,000
1882	10,000	700,000	1892	27,500	2,200,000
1883	12,000	840,000	1893	24,059	1,804,420
1884	13,000	910,000	1894	19,987	1,399,090
1885	15,000	1,050,000	1895	20,710	1,449,700
1886	18,000	1,440,000	1896	20,000	1,400,000
1887	18,000	1,440,000	1897	25,000	1,750,000
1888	20,000	1,600,000	1898	33,000	2,310,000
1889	16,970	1,357,600	1899	40,146	3,211,680

IMPORTS.

The imports of zinc white in 1899 were less than in any year since 1892, indicating, when taken in consideration with the increased production, that the domestic product has displaced a considerable quantity of foreign material in the home markets. The following table exhibits the amount of zinc white imported into the United States since 1885:

Imports of zinc oxide from 1885 to 1899, inclusive.

Year ending—	Dry.	In oil.	Year ending—	Dry.	In oil.	Total value.
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	
June 30, 1885	2,233,128	98,566	Dec. 31, 1893	3,900,749	254,807	....
Dec. 31, 1886	3,526,289	79,788	1894	3,371,292	59,291	$122,690
1887	4,961,080	123,216	1895	4,546,049	129,343	153,641
1888	1,401,342	51,985	1896	4,572,781	311,023	161,188
1889	2,686,861	66,240	1897	5,564,763	502,357	206,636
1890	2,631,458	102,298	1898	3,342,235	27,050	130,039
1891	2,839,351	128,140	1899	3,012,709	41,699	172,359
1892	2,442,014	111,190				

BARYTES.

PRODUCTION.

The production of crude barytes or heavy spar in 1899 was 41,894 short tons, worth $139,528, as compared with 31,306 short tons, valued at $108,339 in 1898. There was a slight decline in the average price per ton, but the price for 1899 was, with the exception of 1898, the best in five years.

The production of crude barytes in the United States since 1882 has been as follows:

Production of crude barytes from 1882 to 1899.

Year.	Quantity.	Value.	Average price per ton.	Year.	Quantity.	Value.	Average price per ton.
	Short tons.				*Short tons.*		
1882	22,400	$80,000	$3.57	1891	31,069	$118,363	$3.81
1883	30,240	108,000	3.57	1892	32,108	130,025	4.05
1884	28,000	100,000	3.57	1893	28,970	88,506	3.06
1885	16,800	75,000	4.46	1894	23,335	86,983	3.73
1886	11,200	50,000	4.46	1895	21,529	68,321	3.17
1887	16,800	110,000	*a*6.55	1896	17,068	46,513	2.72
1888	22,400	75,000	3.35	1897	26,042	58,295	2.24
1889	21,460	106,313	*b*4.95	1898	31,306	108,339	3.50
1890	21,911	86,505	3.95	1899	41,894	139,528	3.33

a Value at St. Louis and includes some floated barytes.
b Value includes floated barytes when sold first in that form.

IMPORTS.

The following table shows the imports of barytes into the United States from 1867 to 1899:

Imports of barytes from 1867 to 1899.

Year ending—	Manufactured.		Unmanufactured.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
June 30, 1867	14,968,181	$141,273		
1868	2,755,547	26,739		
1869	1,117,335	8,565		
1870	1,684,916	12,917		
1871	1,385,004	9,769		
1872	5,804,098	43,521		
1873	6,939,425	53,759		
1874	4,788,966	42,235		
1875	2,117,854	17,995		
1876	2,655,349	25,325		
1877	2,388,373	19,273		
1878	1,366,857	10,340		
1879	453,333	3,496		
1880	4,924,423	37,374		
1881	1,518,322	11,471		
1882	562,300	3,856		
1883	411,666	2,489		
1884	3,884,516	24,671	5,800,816	$8,044
1885	4,095,287	20,606	7,841,715	13,567
Dec. 31, 1886	3,476,691	18,338	6,588,872	8,862
1887	4,057,831	19,769	10,190,848	13,290
1888	3,821,842	17,135	6,504,975	9,037
1889	3,601,506	22,458	13,571,206	7,660
1890	*a* 1,563	16,453	*a* 4,815	13,133
1891	2,149	22,041	2,900	8,816
1892	1,389	15,419	2,789	7,418
1893	1,032	11,457	2,983	7,612
1894	836	10,556	1,884	5,270
1895	1,629	17,112	2,551	7,561
1896	2,467	23,345	509	1,274
1897	1,300	13,822	502	579
1898	687	8,678	1,022	2,678
1899	2,111	22,919	1,739	5,488

a Long tons since 1890.

FULLER'S EARTH.

PRODUCTION.

Small amounts of fuller's earth were mined in New York, Colorado, and Utah in 1899, but the bulk of the product, as in earlier years, was from the vicinity of Quincy, Florida. The total production in 1899 was 12,381 short tons, valued at $79,644, a decline from 14,860 short tons, valued at $106,500, in 1898. The decrease in domestic production was probably due to larger importations of English earth, these having increased from 8,353 long tons (equivalent to 9,355 short tons) in 1898 to 10,320 long tons (or 11,558 short tons) in 1899. The decrease in domestic production was 2,479 short tons; the increase in imports was 3,203 short tons; the difference (724 short tons) would represent a normal increase in consumption. The production of fuller's earth in the United States for the last five years is shown in the following table:

Production of fuller's earth in the United States from 1895 to 1899.

Year.	Quantity.	Value.
	Short tons.	
1895	6, 900	$41, 400
1896	9, 872	59, 360
1897	17, 113	112, 272
1898	14, 860	106, 500
1899	12, 381	79, 644

IMPORTS.

The amount and value of the fuller's earth imported into the United States in 1897, 1898, and 1899 are shown in the following table:

Fuller's earth imported into the United States during 1897, 1898, and 1899.

Class.	1897.*a*		1898.		1899.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*	
Unwrought or unmanufactured	2, 308	$14, 283	2, 038	$15, 921	3, 743	$23, 194
Wrought or manufactured	2, 138	20, 037	6, 315	55, 123	6, 577	46, 446
Total	4, 446	34, 320	8, 353	71, 044	10, 320	69, 640

a July to December only.

In the following table is shown the amount and value of the fuller's earth imported from 1867 to 1883, by fiscal years. The wrought and unwrought earths were not classified separately during this period. From July 1, 1883, to June 30, 1897, fuller's earth was not reported separately in the custom-house returns to the Treasury Department, but was included with other minerals "not elsewhere specified."

Imports of fuller's earth from 1867 to 1883.

Year ending June 30—	Quantity.	Value.	Year ending June 30—	Quantity.	Value.
	Long tons.			*Long tons.*	
1867	280	$3,113	1876	246	$3,097
1868	211	2,522	1877	400	4,460
1869	324	3,587	1878	335	4,095
1870	239	2,619	1879	361	4,269
1871	290	3,383	1880	578	6,925
1872	274	3,358	1881	268	3,207
1873	251	2,978	1882	908	11,444
1874	277	3,440	1883	1,241	14,309
1875	300	3,694			

DEVELOPMENTS OF THE INDUSTRY IN THE UNITED STATES.

For many years fuller's earth was used only as a detergent in fulling cloth, but with the increased use of cotton-seed oil English fuller's earth came to be used for decolorizing such vegetable oils, and also lard oils. This increased the importation of fuller's earth very markedly, as shown in the preceding table.

In 1893 good fuller's earth was discovered quite accidentally in the United States. At Quincy, Florida, an effort was made to burn brick from the clay found on the lands of The Owl Cigar Company. The effort was a failure, for fuller's earth when burned exfoliates instead of forming a coherent mass, suitable for bricks. An Alsatian cigar-maker employed by the company called attention to the close resemblance of this clay to the German fuller's earth; and as a result the material found sale, and the industry was developed. Its use as a substitute for bone black in the filtering of mineral oils extended rapidly, although the fuller's earth was the more expensive material. It is principally for such purposes that the American earth is now used, the English earth being preferred for cotton-seed and lard oils. The development of the industry in this country was sufficient to cause a widespread interest in the search for fuller's earth, and thousands of samples were examined by the chemists of various consumers. Most of the samples were worthless, and yet enough good

samples were obtained to show that the region to the west and north of Quincy contained many other available deposits if needed. The search extended over the United States, and deposits were soon found in New York, Virginia, North Carolina, Georgia, at various places in Florida, and in Indian Territory, Nebraska, Colorado, Utah, New Mexico, and South Dakota. A small producing industry has been developed in New York State and in Colorado and Utah, but the principal supply continues to come from the developed deposits at Quincy, Florida. The reason for this is the great variation in quality of the earth from different deposits. That from North Carolina and Virginia is more or less sandy; that from Georgia is almost identical with the Quincy earth, but is not favorably located for shipment. All the other deposits are less accessible, with the exception of one, near Tampa, which promises soon to be a large source of supply. Curiously enough the material produced in Florida bears little outward resemblance to the earth which has long been imported from England.

The earth discovered in South Dakota is almost the exact duplicate of the English earth, and will no doubt become a valuable substitute for it.

Fragments of chert are common in beds of fuller's earth, and in Georgia fuller's earth passes almost indistinguishably into layers of chert, with almost the same color and fracture. At Ballert Point, near Tampa, Florida, the fuller's earth contains many oyster shells, bits of coral, etc., all entirely changed to chalcedony. This leads to the hypothesis that this earth probably originated in ordinary clay, which has received from interfiltering solutions an additional supply of silicic acid, which sometimes combined with the clay, and occasionally was deposited as chert.

The conditions of occurrence of fuller's earth and the manner of preparing it for market are quite simple. In Florida it may be found outcropping at the foot of slopes around the edges of swamps. The clays appear to occur in large, shallow basins in the swampy tracts characteristic of the region around Quincy and of many other parts of the State. Usually there will be 1 or 2 feet of surface soil, then 2 to 6 feet of mottled plastic clay, then the fuller's earth in layers varying in thickness of from 2 to 12 feet, then a layer of sand mixed with fuller's earth, which is usually persistent for a considerable depth below the deposit. Occasionally a second deposit of fuller's earth, bluish in color, will be found below the first, with a layer of sand intervening. Up to this time the simplest methods have been used in preparing the material. The overburden of sand and worthless plastic clay is removed, and the wet fuller's earth chopped out in thin slices with mattocks and allowed to dry in the sun for several days. By this means the wet, greenish clay loses perhaps 50 per cent of its weight, turns to

a creamy white color, becomes very brittle, and easily splits into thin layers. It then contains 15 per cent of its weight of water, which can only be driven off above the boiling point. Lately artificial dryers and an arrangement for grinding the earth to the requisite fineness have been introduced. The process of levigating the earth, which is quite common in Surrey, England, is not used in this country at all. The Florida earth, ground to 60 mesh and finer, is used almost entirely as a substitute for bone black in filtering mineral lubricating oils, although its use has been somewhat extended for the lightening of the color of cotton-seed oil, but for this latter purpose the employment of English fuller's earth is still generally practiced. The English earth is taken out by the ordinary method, and then washed in long, narrow troughs, very much like hydraulic sluice boxes, allowing quite a large percentage of the material to settle out as sand, while the lighter material goes off into settling tanks, in which it is finally dried and sold in the resulting lump form. The English earth has not proved any more suitable for the refining of mineral oils than has the American earth for use in vegetable oils. The common practice with these mineral oils is to dry the earth carefully, after it has been ground to 60 mesh, and run it into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. As a result the oil which comes out first is perfectly water-white in color, and markedly thinner than that which follows. The oil is allowed to continue percolating through the fuller's earth until the color reaches a certain maximum shade, when the process is stopped, to be continued with a new portion of earth. The oil is recovered from the spent earth.

With the vegetable oils the process is radically different. The oil is heated to beyond the boiling point of water, in large tanks, and from 5 to 10 per cent of its weight of fuller's earth is then added, and the mixture vigorously stirred for twenty minutes, and then filtered off through bag filters. The coloring matter remains with the earth, leaving oil of a very pale straw color, provided the original cotton-seed oil had been sufficiently well refined by the ordinary process to admit of this, and provided the operation had been conducted with sufficient care. Perhaps the most remarkable feature of this filtration by fuller's earth is the different rate of speed at which oils of different density (in such a mixture of oils as is found in ordinary crude petroleum) will percolate through, with the result that the first oil which makes its appearance is not only very much lighter in color, but markedly lower in specific gravity. In fact, by this process separations can be made which are quite comparable with the results of fractional distillation.

FELDSPAR AND QUARTZ.

By Heinrich Ries.

FELDSPAR.

PRODUCTION.

The production of feldspar in 1899 amounted to 27,202 short tons, valued at $238,545, as against 13,440 short tons in 1898, with a value of $32,395. The production was distributed as follows:

Production of feldspar in 1899.

State.	Short tons.	Value.
Connecticut and Maine	8,122	$49,495
New York and Pennsylvania	12,830	127,550
Miscellaneous *a*	6,250	61,500
Total	27,202	238,545

a This includes the output of several mills at Trenton and East Liverpool, whose product is drawn from different States.

OCCURRENCE AND USES.

While feldspar, or "spar" as it is called commercially, is a common rock-forming mineral, deposits of economic value are comparatively rare, for the reason that it is frequently intimately associated with other minerals, as quartz and mica, in granite, syenite, etc.

The feldspar of commerce is obtained from veins in which other minerals are rare, these veins being usually found in igneous or metamorphic rocks, such as granite, gneiss, or schist, and more rarely in serpentine, as in southeastern Pennsylvania.[1] Those veins, which are worked, often contain some quartz and mica, but these two impurities may be segregated into bunches, so that they can be avoided in mining or easily picked out of the blasted material by hand. There are, indeed, some veins which contain both quartz and feldspar in large but separated masses.

[1] Min. Indus., VII, p. 263.

The feldspar commonly quarried in the United States is of a cream color, but much of that mined in Europe is deep red.[1] Depending on the variety, feldspar may also exhibit white, bluish, or green tints All feldspars cleave readily; the common cream-colored species, orthoclase, showing two cleavages or planes of splitting, which are nearly at right angles to each other. The presence of this cleavage distinguishes feldspar from quartz, and it has also greater softness, being only 6, while quartz is 7.

Chemically, feldspar is a complex silicate of alumina, with potash, soda, or lime, and the identity of the different varieties is based on their chemical composition and crystal structure.[2] It is important to take notice of this difference in chemial composition since it effects the fusibility.

The following table gives the composition of the more important varieties of feldspar:

Composition of feldspars.

Name.	Silica.	Alumina.	Potash.	Soda.	Lime.	Ferrous oxide.
Orthoclase	64.7	18.4	16.9	....	....	....
Plagioclase:						
Anorthite	43.2	36.7	....	....	20.1	....
Albite	68.7	19.5	....	11.8	....	....
Oligoclase	64.0	24.0	2.0	9.0	3.0	....
Labradorite	54.0	29.0	....	5.0	11.0	1.0

The last four are known collectively as plagioclase or lime-soda feldspars, and can be often told by the fact that certain of their cleavage surfaces show a striated appearance.

The orthoclase is the most refractory of the series, fusing at about 1180° C., while the others fuse at lower temperatures. Most of the feldspar in the American market is probably orthoclase, but a systematic chemical examination of the American deposits has not thus far been carried out.

Feldspar for pottery use should be free from iron oxide, and should fuse to a white glass. The red color of some feldspars does not always indicate the presence of iron, for many like this calcine to a white mass.

Feldspar is quarried by the ordinary methods of blasting. In the Southern States the deposit may be capped by residual clay or kaolin, and it may be more profitable to market this white clay. When such

[1] Kaolins and fire clays of Europe: Nineteenth Ann. Rept. U. S. Geol. Survey, Part VI, continued, p. 450.

[2] See Dana. System of Mineralogy.

clay exists the unaltered spar may not be reached for a depth of 60 feet or more. In the Northern States the capping of residual material is commonly wanting.

After the feldspar is quarried any lumps of impurities are eliminated by hand picking, after which the material is ground to coarse sand under buhrstones and then further pulverized in ball mills with flint pebbles.

The price of feldspar commonly varies from $3 to $6 per ton at the quarry, depending on the quality of the material.

Pennsylvania, Connecticut, and Maine are important producers.

Feldspar is extensively employed as a fluxing and binding agent in the body of white earthenware, porcelain, and floor tiles. It is also an ingredient of the glaze of hard porcelain. As a constituent of glass it serves to furnish alumina for the purpose of hardening the product. Many tons are annually consumed in the manufacture of wood filler and certain scouring soaps. For the latter purpose it possesses certain advantages over quartz, for being softer it scratches less.

QUARTZ.

PRODUCTION.

The production of quartz or "flint" in 1899 amounted to 36,852 short tons, valued at $229,345, as against 21,426 short tons in 1898, valued at $42,670.

In the following table it is not possible to give the production of each State separately, since there was only one producer in some, and it is necessary to lump this in with another State in order not to publish the figures of individual producers.

Production of quartz in 1899.

State.	Short tons.	Value.
Connecticut	7,846	$49,030
Maine	7,167	50,336
Maryland	2,700	6,750
Alabama, New York, Pennsylvania, Wisconsin, etc.	19,139	123,229
Total	36,852	229,345

OCCURRENCE AND USES.

The quartz included in the above figures consists mostly of vein quartz, which is the form chiefly used by potters. Two other sources of this material are the flint pebbles found in Cretaceous rocks in some regions and some silicified deposits occurring in the Tertiary.

Vein quartz is commonly the purest form of quartz and occurs under practically the same conditions and often in the same regions as feldspar. Maine and Connecticut are the most important producers, but New York, Maryland, and Alabama also yield supplies.

In Europe most of the quartz used by pottery manufacturers is obtained from the flint pebbles found in the Cretaceous chalk of England, France, and Germany. These pebbles, although of grayish color, are white when calcined. They are imported to the United States for potters purposes and for use in ball mills. None are obtained in this country, although they are said to occur in Texas. At present these have little value, owing to their distance from the Eastern market. Imported pebbles sell in Trenton for $1.75 to $2 per ton.

The methods of mining and grinding quartz are the same as those used in the extraction and preparation of feldspar. The powdered product passes entirely through a 100-mesh sieve and much of it through a 150 mesh.

Quartz is used as an ingredient of white earthenware, porcelain, floor tile, and wall tile bodies to prevent excessive fire shrinkage. Much is employed in the manufacture of wood filler, and certain scouring soaps; also for sandpaper, glass making, filters, and acid towers.

The price of ground quartz varies from $5 to $6 per ton.

MINERAL WATERS.

By A. C. Peale.

PRODUCTION.

For the year 1899 we have the largest list of springs yet published, 541 springs being represented upon it, as compared with 484 for 1898. This is a gain of 57 springs, 70 springs, new to the list, having been added and 13 dropped. Of these 541 springs, 62 are not represented by any figures in the present report, although 33 of them report that no sales were made in 1899. Of the remaining 29, nearly one-half reported sales for 1898, and for this year they are estimated, as usual, at one-half the previously reported figures. The report for this year is based on returns from 73 more springs than was the report for 1898.

In three of the sections there has been an increase in the number of gallons sold, and in two there has been a decrease, but the net increase for the whole country has been very considerable. Notwithstanding this increase in the production, there is a large decrease in the value as compared with that of 1898. This is owing partly to the fact that a large portion of the increase has been due to increased sales of potable waters at low prices, and also to the fact that some springs which reported large sales at comparatively high figures in 1898 have made no reports for 1899. This has also had the effect of lowering the average price per gallon from 27.9 cents for 1898 to about 17.5 cents for 1899. The average prices per gallon for the five years prior to 1898 are as follows: For 1893, 18 cents; 1894, 17 cents; 1895, 19 cents; 1896, 16.25 cents, and 1897, 20 cents.

For 1899 the total production was 39,562,136 gallons, which is 10,708,672 gallons more than the amount reported for 1898. The total value of the product for 1899 is $6,948,030, a decrease of $1,103,803 from 1898.

When the comparison is made of the figures for the 479 springs actually reporting in 1899 with those of the 406 reporting in 1898 the increase in the number of gallons reported is 9,339,900 and the decrease in the value is $2,441,799.

The North Atlantic States make a net gain of 27 springs, 32 having been added to the list and 5 dropped, leaving the total for the section

185, as compared with 158 for 1898. Of these, 171 have reported sales amounting to 13,674,764 gallons, with a value of $2,003,388, which is an increase from 1898 of 2,513,464 gallons and a decrease in value of $1,285,527.

The 32 springs new to the list of 1899 are as follows:

Connecticut: Mohican Springs (formerly Fairfield Springs).

Maine: Floral Glen Spring, Highland, Ledge and Boiling Springs, Hillside Springs, Minot Mineral Spring, Mount Zircon Spring, Oak Grove Spring, Sabattus Mineral Spring.

Massachusetts. Berkshire Soda Springs, Calumet Mineral Spring, Granite Rock Spring, Lovers Leap Springs. Miscoe Spring, Mount Washington Cold Spring, Sand Springs, Smiley Spring, Stevens Spring.

New Hampshire. Granite State Spring, Gorham Mineral Spring, Lafayette Mineral Spring.

New Jersey: Beech Springs, Hatawanna Spring, Oakland Spring.

New York: Geneva Red Cross Lithia Spring (formerly Chase Spring), Nauroshonk Spring, Saratoga Quevic Spring, Rockdale Mineral Spring, Split Rock Springs.

Pennsylvania· Corry Artesian Mineral Spring, Whann Alkaline Lithia Mineral Springs.

Rhode Island: Wakefield Mineral Water Well.

Vermont: Montvert Spring.

The South Atlantic States for 1899 gain 6 springs, the total number on the list being 92, as compared with 86 for the year 1898. The new springs added are 8 in number, and 2 were dropped from the list. Reports of sales were received from 79, which is 8 more than were represented in the figures of 1898.

The total production for the section is reported as 1,826,543 gallons, with a value of $469,579. This is a loss of 3,247,398 gallons from 1898 and a decrease in value of $2,695,592. The following is the list of springs, 8 in all, new to the list for 1899:

District of Columbia: Gitchie Mineral Spring.

Maryland: Bandusia Spring, Bladensburg Spa, Rockhill Spring.

Virginia: Bear Lithia Springs, Golindo Lithia Springs, Jeffress Lithia Springs, Houston Lithia Well.

In the North-Central States the total number of springs on the list for 1899 is 148, a gain of 18 over the list of 1898, which contained 130 springs. There have been added 19 new springs, while 1 has been dropped. Reports of sales have been received from 124, leaving 24 on the delinquent list. The total number of gallons sold in 1899 is reported as 13,496,723, which is an increase of 5,997,160 gallons over the production of 1898. The value of the product of 1899 is given as $1,734,727, an increase from that of 1898 of $838,574. The 19 new springs added to the list for this section are the following:

Illinois: Anna Mineral Springs, Diuretin Springs.

Indiana: Grove Mineral Well, Home Lawn Mineral Springs.

Iowa: Boone Mineral Well.

Kansas: Sycamore Mineral Springs.

Michigan; Cooper Farm Spring, Frankfort Springs, Original Mount Clemens Mineral Spring, Wurtzel Mineral Springs.

Missouri: American Springs, Livertone Springs, Windsor Springs.

Ohio: Mineral Springs of Adams County, Oakridge Spring, The Odovene Spring, Wheeler's Mineral Springs.

Wisconsin: Clysmic Spring of Waukesha, Slauson Mineral Spring.

For the South-Central States there is a net gain of 3 springs. The new springs added to the list are 5, and 2 were dropped, leaving the total at 46, instead of 43, as in 1898. Of these, 41 report sales in 1899, which is 6 more than were heard from in 1898. The production for 1899 is reported as 5,599,152 gallons, with a value of $311,388. This is an increase over 1898 of 4,345,635 gallons, and, $217,951. The 5 springs new to the list of 1899 are the following:

Mississippi: Arundel Lithia Springs.

Tennessee: Wright's Epsom Lithia Well.

Texas: Dullnig Mineral Wells, Pal-Pinto Crystal Wells, Sour Lake Mineral Springs.

The Western States and Territories also gain 3 springs, 6 having been added to the list and 3 dropped from it. The total number for 1899 in the list for the section is 70, as compared with 67 for 1898. Of these, 64 report sales for 1899. This is 2 more than for 1898. The production reported for 1899 is 2,424,357 gallons, a decrease of 268,961 gallons from 1898. The value for 1899, however, is $482,795 more than that of 1898, being $965,612. The 6 springs new to the list in 1899 are the following:

California: Buckman Springs, Carlsbad Spring, Napa Vichy Springs, Paraiso Hot Springs, Sulphur Mountain Springs.

Colorado: The Dr. Horn Mineral Springs.

Production of mineral waters in 1899 by States and Territories.

State or Territory.	Springs reporting.	Product.	Value.
		Gallons.	
Alabama	4	38,900	$19,917
Arkansas	5	48,602	17,442
California	38	1,464,075	698,493
Colorado	11	642,850	172,970
Connecticut	12	338,017	50,685
District of Columbia	2	168,500	10,275
Florida	2	17,000	7,250
Georgia	6	128,040	24,770
Illinois	18	858,950	101,090
Indiana	12	162,475	25,255
Iowa	3	40,200	3,320
Kansas	6	36,175	2,718

Production of mineral waters in 1899 by States and Territories—Continued.

State or Territory.	Springs reporting.	Product.	Value.
		Gallons.	
Kentucky	4	63,500	$7,032
Maine	26	1,850,132	179,450
Maryland	11	100,380	13,045
Massachusetts	39	4,439,041	230,704
Michigan	21	3,045,400	368,235
Minnesota	4	2,078,700	54,704
Mississippi	6	271,500	48,292
Missouri	12	551,876	262,705
New Hampshire	6	469,800	190,990
New Jersey	7	332,000	171,380
New Mexico	5	46,800	7,770
New York	46	4,454,057	809,056
North Carolina	7	103,150	20,715
Ohio	15	2,494,473	171,135
Oregon	2	45,500	9,700
Pennsylvania	25	1,542,800	340,254
Rhode Island	4	195,000	15,000
South Carolina	5	322,564	33,450
South Dakota	2	138,645	44,073
Tennessee	6	346,700	55,658
Texas	15	4,729,950	155,047
Utah	3	7,850	1,955
Vermont	6	53,917	15,869
Virginia	39	954,689	341,769
Washington	3	54,000	7,002
West Virginia	7	32,220	18,305
Wisconsin	30	4,089,329	701,367
Other States *a*	4	263,782	75,847
Total	479	37,021,539	5,484,694
Estimated production of springs not reporting sales	62	2,540,597	1,463,336
Grand total	541	39,562,136	6,948,030

a The States in which only one spring for each has made a report are included here. These States are Idaho, Louisiana, Montana, and Nebraska.

Production of natural mineral waters from 1883 to 1899.

Geographic division.	Springs reporting.	Quantity sold.	Value.
1883.		*Gallons.*	
North Atlantic	38	2,470,670	$282,270
South Atlantic	27	312,090	64,973
North Central	37	1,435,809	323,600
South Central	21	1,441,042	139,973
Western	6	169,812	52,787
	129	5,829,423	863,603
Estimated	60	1,700,000	256,000
Total	189	7,529,423	1,119,603
1884.			
North Atlantic	38	3,345,760	328,125
South Atlantic	27	464,718	103,191
North Central	37	2,070,533	420,515
South Central	21	1,526,817	147,112
Western	6	307,500	85,200
	129	7,715,328	1,084,143
Estimated	60	2,500,000	375,000
Total	189	10,215,328	1,459,143
1885.			
North Atlantic	51	2,527,310	192,605
South Atlantic	32	908,692	237,153
North Central	45	2,925,288	446,211
South Central	31	540,436	74,100
Western	10	509,675	86,776
	169	7,411,401	1,036,845
Estimated	55	1,737,000	276,000
Total	224	9,148,401	1,312,845
1886.			
North Atlantic	49	2,715,050	177,969
South Atlantic	38	720,397	123,517
North Central	40	2,048,914	401,861
South Central	31	822,016	58,222
Western	14	781,540	137,796
	172	7,087,917	899,365
Estimated	53	1,862,400	384,705
Total	225	8,950,317	1,284,070

Production of natural mineral waters from 1883 to 1899—Continued.

Geographic division.	Springs reporting.	Quantity sold.	Value.
1887.		*Gallons.*	
North Atlantic	40	2,571,004	$213,210
South Atlantic	34	614,041	147,149
North Central	38	1,480,820	208,217
South Central	29	741,080	87,946
Western	12	1,236,324	288,737
	153	6,643,269	945,259
Estimated	62	1,616,340	316,204
Total	215	8,259,609	1,261,463
1888.			
North Atlantic	42	2,856,799	247,108
South Atlantic	32	1,689,387	493,489
North Central	38	2,002,373	325,839
South Central	19	426,410	71,215
Western	15	1,853,679	421,651
	146	8,828,648	1,559,302
Estimated	52	750,000	120,000
Total	198	9,578,648	1,679,302
1889.			
North Atlantic	60	4,106,464	471,575
South Atlantic	47	646,239	198,032
North Central	86	6,137,776	604,238
South Central	33	500,000	43,356
Western	32	1,389,992	431,257
Total	258	12,780,471	1,748,458
1890.			
North Atlantic	55	5,043,074	1,175,512
South Atlantic	39	647,625	245,760
North Central	71	5,050,413	737,672
South Central	30	604,571	81,426
Western	25	869,504	253,578
	220	12,215,187	2,493,948
Estimated	53	1,692,231	106,802
Total	273	13,907,418	2,600,750

Production of natural mineral waters from 1883 to 1899—Continued.

Geographic division.	Springs reporting.	Quantity sold.	Value.
1891.		*Gallons.*	
North Atlantic	62	5,724,752	$1,591,746
South Atlantic	41	796,439	313,443
North Central	68	8,010,556	482,082
South Central	29	629,015	106,022
Western	27	1,123,640	414,564
	227	16,284,402	2,907,857
Estimated	61	2,108,330	88,402
Total	288	18,392,732	2,996,259
1892.			
North Atlantic	65	6,853,722	1,933,416
South Atlantic	47	1,062,945	353,193
North Central	74	11,566,440	1,834,732
South Central	32	693,544	109,334
Western	24	1,261,453	594,469
	242	21,438,104	4,825,144
Estimated	41	438,500	80,826
Total	283	21,876,604	4,905,970
1893.			
North Atlantic	79	8,351,192	1,844,845
South Atlantic	49	1,092,829	304,736
North Central	78	8,833,712	1,073,427
South Central	35	1,139,959	122,331
Western	29	675,041	307,623
	270	20,092,733	3,652,962
Estimated	60	3,451,762	593,772
Total	330	23,544,495	4,246,734
1894.			
North Atlantic	83	8,217,528	1,488,361
South Atlantic	55	660,120	129,143
North Central	82	6,914,900	1,115,322
South Central	37	2,319,813	273,836
Western	29	859,905	274,235
	286	18,972,266	3,280,897
Estimated	71	2,597,342	460,949
Total	357	21,569,608	3,741,846

Production of natural mineral waters from 1883 to 1899—Continued.

Geographic division.	Springs reporting.	Quantity sold.	Value.
1895.		*Gallons.*	
North Atlantic	88	8, 668, 907	$1, 572, 881
South Atlantic	51	953, 713	287, 623
North Central	92	6, 428, 582	1, 577, 118
South Central	35	2, 346, 806	161, 073
Western	31	886, 185	292, 832
	297	19, 284, 193	3, 891, 527
Estimated	73	2, 179, 350	362, 710
Total	370	21, 463, 543	4, 254, 237
1896.			
North Atlantic	90	9, 234, 890	2, 069, 336
South Atlantic	60	1, 306, 088	400, 408
North Central	97	8, 123, 080	808, 307
South Central	34	4, 364, 957	255, 943
Western	31	1, 577, 185	400, 998
	312	24, 606, 200	3, 934, 992
Estimated	65	1, 189, 112	201, 200
Total	377	25, 795, 312	4, 136, 192
1897.			
North Atlantic	125	9, 708, 266	2, 607, 357
South Atlantic	68	1, 244, 563	347, 717
North Central	104	6, 281, 931	718, 182
South Central	36	2, 432, 647	129, 185
Western	48	2, 694, 875	703, 179
	381	22, 362, 282	4, 505, 620
Estimated	60	893, 629	93, 486
Total	441	23, 255, 911	4, 599, 106
1898.			
North Atlantic	131	11, 161, 300	3, 288, 915
South Atlantic	71	5, 073, 941	3, 165, 171
North Central	107	7, 499, 563	896, 153
South Central	35	1, 253, 517	93, 437
Western	62	2, 693, 318	482, 817
	406	27, 681, 639	7, 926, 493
Estimated	78	1, 171, 825	125, 340
Total	484	28, 853, 464	8, 051, 833

Production of natural mineral waters from 1883 to 1899—Continued

Geographic division.	Springs reporting	Quantity sold.	Value.
1899.		*Gallons.*	
North Atlantic	171	13, 674, 764	$2, 003, 388
South Atlantic	79	1, 826, 543	469, 579
North Central	124	13, 496, 723	1, 734, 727
South Central	41	5, 599, 152	311, 388
Western	64	2, 424, 357	965, 612
	479	37, 021, 539	5, 484, 694
Estimated	62	2, 540, 597	1, 463, 336
Total	541	39, 562, 136	6, 948, 030

LIST OF COMMERCIAL SPRINGS.

The list following contains the names of those springs only that are represented in the figures given in the table of production; that is, only those reporting sales for the year 1899:

ALABAMA.

All the springs credited to the State of Alabama report for 1899. They are 4 in number, and are as follows:

Bailey Springs, Bailey Springs, Lauderdale County.
Healing Springs, Healing Springs, Washington County.
Jackson White Sulphur Springs, Jackson, Clarke County.
Wilkinson's Matchless Mineral Water, Greenville, Butler County

ARKANSAS.

The list for Arkansas includes seven springs. Of these, 5 report sales in 1899. They are the following:

Arkansas Lithia Springs, Hope, Hempstead County.
Blanco Springs, near Hot Springs, Garland County.
Dovepark Springs, Dovepark, Hot Spring County.
Eureka Springs, Eureka Springs, Carroll County.
Potash Sulphur Spring, Hot Springs, Garland County.

CALIFORNIA.

For 1899 California makes a net gain of 2 springs, 5 new springs having been added to the list and 3 dropped, leaving the total at 40. Of these 38 report sales in 1899. They are the following:

Adams Springs, Lake County.
Ætna Springs, Lidell, Napa County.
Alhambra Mineral Spring, Martinez, Contra Costa County.

Allen Springs, Allen Springs, Lake County.
Almaden Vichy Springs, New Almaden, Santa Clara County.
Azule Natural Seltzer Water, San Jose, Santa Clara County.
Bartlett Springs, Bartlett Springs, Lake County.
Buckman Springs, near Descanso, San Diego County.
Byron Hot Springs, Byron Hot Springs, Contra Costa County.
Bythnia Springs, Santa Barbara, Santa Barbara County.
Carlsbad Spring, Calsbad, San Diego County.
Castalian Springs, Sierra Nevada Mountains, Inyo County.
Castle Rock Natural Mineral Spring, Castella, Shasta County.
Cooks Springs, near Williams, Colusa County.
Coronado Mineral Spring, Coronado, San Diego County.
Duncan Springs, Hopland, Mendocino County.
Fouts Springs, Snow Mountain, Colusa County.
Highland Springs, near Clear Lake, Lake County.
Humboldt Springs, Eureka, Humboldt County.
Isham Springs, near San Diego, San Diego County.
Lytton Soda, Seltzer, and Carlsbad Springs, Lytton, Sonoma County.
Madrone Mineral Springs, Santa Clara County.
Mercy Medicinal Well, Little Panoche, Fresno County.
Mount Ida Mineral Spring, Oroville, Butte County.
Napa Soda Springs, Napa Soda Springs, Napa County.
Napa Vichy Springs, near Napa City, Napa County.
Pacific Congress Springs, Saratoga, Santa Clara County.
Paraiso Hot Springs, Monterey County.
Paso Robles Springs, Paso Robles, San Luis Obispo County.
Ramona Natural Mineral Spring, Los Angeles, Los Angeles County.
Samuel Soda Springs, east of St. Helena, Napa County.
San Benito Springs, Tres Pinos, San Benito County.
Shasta Springs, Shasta Springs, Siskiyou County.
Sulphur Mountain Springs, Santa Paula, Ventura County.
Tassajara Hot Springs, Monterey County.
Tolenas Springs, near Suisun, Solano County.
Tuscan Springs, Redbluff, Tehama County.
Veronica Springs, Santa Barbara, Santa Barbara County.

COLORADO.

Colorado gains 1 new spring, making the total for 1899 on the list 13. Of these 11 report sales. They are the following:

Boulder Springs, Boulder Canyon, Boulder County.
Canyon City Vichy Springs, Canyon City, Fremont County.
Carlile Soda-Iron Springs, near Pueblo, Pueblo County.
Clark Magnetic Mineral Springs, near Pueblo, Pueblo County.
Colorado Carlsbad Springs, Barr, Arapahoe County.
Manitou Iron Spring, Manitou, El Paso County.
Manitou Mineral Springs, Manitou, El Paso County.
    Cheyenne Spring.
    Manitou Spring.
    Navajo Spring.
    Shoshone Spring.
Strontia Medicinal Spring, near Deansbury, Douglas County.
The Dr. Horn Mineral Springs, Colorado Springs, El Paso County.
The Ximo Spring, Soda Springs, Lake County.
Yampah Springs, Glenwood Springs, Garfield County.

CONNECTICUT.

The total on the list for Connecticut remains at 13 for 1899, as in 1898, having gained 1 spring and lost 1. All but 1 report sales in 1899, the 12 springs reporting being the following:

Althea Springs, Waterbury, New Haven County.
Arethusa Springs, Seymour, New Haven County.
Aspinock Mineral Springs, Putnam Heights, Windham County.
Cherry Hill Spring, Hamden, New Haven County.
Highland Rock Mineral Spring, Highland Park, Hartford County.
Live Oak Spring, Meriden, New Haven County.
Mohican (formerly Fairfield) Springs, Fairfield, Fairfield County.
Oxford Mineral Spring, Oxford, New Haven County.
Stafford Mineral Spring, Stafford Springs, Tolland County.
Stillman Homestead Springs, Bridgeport, Fairfield County.
The Puritan Spring, Norwich, New London County.
Tonica Springs, Highland Park, Hartford County.

DISTRICT OF COLUMBIA.

The list for the District of Columbia now includes 2 springs, there having been 1 added for 1899. Both springs report as follows:

Columbia Natural Lithia Spring, Washington.
Gitchie Crystal Spring, Bennings.

FLORIDA.

There is no change in the list for Florida, the 2 springs credited to the State reporting sales for 1899. They are as follows:

Magnolia Springs, Magnolia Springs, Clay County.
Panacea Mineral Springs, Wakulla County.

GEORGIA.

Georgia loses 1 spring, leaving the total for the State at 7. Of these 6 report for 1899. They are the following:

Anipa Springs, Rome, Floyd County.
Bowden Lithia Springs, Lithia Springs, Douglas County.
Daniel Spring, near Union Point, Greene County.
Hughes Mineral Spring, near Rome, Floyd County.
Medlock Lithia Springs, Austell, Cobb County.
Ponce de Leon Spring, near Atlanta, Fulton County.

IDAHO.

Idaho is still represented on the list by 1 spring which reports for 1899, as follows:

Idanha Spring, Soda Springs, Bannock County.

ILLINOIS.

Illinois gains 2 springs, bringing the total up to 21. Of these 18 report sales for 1899. They are as follows:

Anna Mineral Springs, Anna, Union County.
Aurora Lithia Spring, Montgomery, Kane County.

Black Hawk Springs, Rock Island, Rock Island County.
Cumberland Mineral Spring, near Greenup, Cumberland County.
Deer Lick Mineral Spring, Deerfield, Lake County.
Diamond Mineral Springs, Grantfork, Madison County.
Diuretin Springs, Quincy, Adams County.
Glen Flora Mineral Springs, Waukegan, Lake County.
Magnesia Spring, Montgomery, Kane County.
Min-ni-ni-yan Spring, Bristol, Kendall County.
Original Springs, Okawville, Washington County.
Perry Mineral Springs, Perry Springs, Pike County.
Red Avon Mineral Spring, Avon, Fulton County.
Sailor Springs, Sailor Springs, Clay County.
Sanicula Springs, Ottawa, Lasalle County.
Sidell Mineral Spring, Sidell, Vermilion County.
Sylvan Dell Sulpho-Magnesia Spring, Galewood, Cook County.
Tivoli Spring, Chester, Randolph County.

INDIANA.

The list for Indiana is increased by 2 springs, making the total for the State 15. Reports of sales have been received from 12, as follows:

Attica Lithia Springs, Attica, Fountain County.
Elliott or Willow Valley Springs, Proctor, Martin County.
French Lick Springs, French Lick, Orange County.
Greenwood Mineral Well, Greenwood, Johnson County.
Grove Mineral Well, Anderson, Madison County.
Home Lawn Mineral Springs, Martinsville, Morgan County.
Indiana Mineral Springs, Indiana Mineral Springs, Warren County.
Kickapoo Magnetic Springs, Kickapoo, Warren County.
King's Mineral Springs, Muddyfork, Clark County.
Lodi Artesian Well, Silverwood, Fountain County.
Magnetic Mineral Springs, Terre Haute, Vigo County.
West Baden Springs, West Baden, Orange County.

IOWA.

Iowa's list gains 1 spring. Of the 6 credited to the State 3 report sales for 1899. They are the following:

Boone Mineral Well, Boone, Boone County.
Colfax Mineral Spring, Colfax, Jasper County.
Ottumwa Mineral Springs, Ottumwa, Wapello County.

KANSAS.

For Kansas the list is increased by 1 spring, making the total 7. Of these 6 report sales for 1899. They are the following:

Blazing's Natural Medical Spring, Manhattan, Riley County.
Geuda Mineral Springs, Geuda Springs, Cowley County.
Iola Mineral Well, Iola, Allen County.
Jewell County Lithium Spring, Montrose, Jewell County.
Sycamore Mineral Springs, Springs, Brown County.
Waconda Springs, Waconda, Mitchell County.

KENTUCKY.

Kentucky's list shows no change from 1898. The total for 1899 remains at 5, and of these 4 report sales. The springs reporting are as follows:

Anita Spring, Lagrange, Oldham County.
Bedford Springs, Bedford, Trimble County.
Bluelick Springs, Bluelick Springs, Nicholas County.
Crab Orchard Springs, Crab Orchard, Lincoln County.

LOUISIANA.

Louisiana is still represented by 1 spring, which reports sales for 1899. It is:

Abita Springs, Abita Springs, St. Tammany Parish.

MAINE.

The State of Maine gains 7 springs. The total for 1899 is 26, and all are represented in the report. They are as follows:

Blue Hill and Dirigo Springs, Blue Hill, Hancock County.
Cold Bowling Spring, Steep Falls, Limington, York County.
Crystal Mineral Springs, Auburn, Androscoggin County.
Floral Glenn Spring, Auburn, Androscoggin County.
Glenrock Springs, Greene, Androscoggin County.
Glenwood Mineral Spring, St. Albans, Somerset County.
Highland, Ledge and Boiling Springs, Poland, Androscoggin County.
Highland Spring, Lewiston, Androscoggin County.
Hillside Springs, Lewiston, Androscoggin County.
Ishka Springs, Hancock, Hancock County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Minot Mineral Spring, West Minot, Androscoggin County.
Mount Hartford Cold Spring, Hartford, Oxford County.
Mount Zircon Spring, Rumford, Oxford County.
Oak Grove Spring, Bremen, Penobscot County.
Oxford Spring, Oxford, Oxford County.
Paradise Spring, Brunswick, Cumberland County.
Pine Spring, Topsham, Sagadahoc County
Poland Springs, Poland Springs, Androscoggin County.
Pownal Spring, West Pownal, Cumberland County.
Sabattus Mineral Spring, Webster, Androscoggin County.
Seal Rock Springs, Saco, York County.
Underwood Spring, Falmouth Foreside, Cumberland County.
Utona Spring, Eastport, Washington County.
Wilson Spring, North Raymond, Cumberland County.
Windsor Mineral Spring, Lewiston, Androscoggin County.

MARYLAND.

There is a net gain of 2 springs for Maryland, 3 having been added and 1 dropped. The total for 1899 is 11, and they all report sales. They are:

Algonquin Springs, Oxen Hill, Prince George County.
Bandusia Spring, Cub Hill, Baltimore County.

Blackiston Island Diuretic Mineral Spring, Blackiston Island, St. Mary County.
Bladensburg Spa, Bladensburg, Prince George County.
Carroll Springs, Forest Glen, Montgomery County.
Chattolanee Springs, Chattolanee, Baltimore County.
Indian Spring, near Sligo, Montgomery County.
Mardela Mineral Spring, Mardela, Wicomico County.
Rock Hill Spring, Rockville, Montgomery County.
Strontia Mineral Spring, Brooklandville, Baltimore County.
Takoma Springs, Takoma, Montgomery County.

MASSACHUSETTS.

For Massachusetts 9 springs are added to the list and 2 dropped, making the total 40 for 1899. Of these all but 1 report sales. The 39 reporting are the following:

Ballardvale Lithia Spring, Ballardvale, Essex County.
Belmont Crystal Spring, Belmont, Middlesex County.
Belmont Hill Spring, Everett, Middlesex County.
Belmont Spring, Belmont, Middlesex County.
Berkshire Soda Spring, Sheffield, Berkshire County.
Burnham Spring, Methuen, Essex County.
Calumet Mineral Spring, Sutton, Worcester County.
Chapman's Crystal Spring, Stoneham, Middlesex County.
Columbia Lithia Spring, Revere, Suffolk County.
Crystal Mineral Spring, Methuen, Essex County.
Diamond Spring, Lawrence, Essex County.
Egypt Springs, Egypt, Plymouth County.
Electric Spring, Lynn, Essex County.
Everett Crystal Spring, Everett, Middlesex County.
Farrington's Silver Spring, Milton, Norfolk County.
Fulton Natural Spring, Medford, Middlesex County.
Geddes Mineral Spring, Marlboro, Middlesex County.
Goulding Spring, Whitman, Plymouth County.
Granite Rock Spring, Brockton, Plymouth County.
Katahdin Spring, Lexington, Middlesex County.
Leland Mineral Spring, Lowell, Middlesex County.
Linden Mineral Spring, Linden, Middlesex County.
Lovers' Leap Springs, Lynn, Essex County.
Massasoit Spring, Springfield, Hampden County.
Miscoe Spring, Mendon, Worcester County.
Monatiquot Spring, South Braintree, Norfolk County.
Moose Hill Spring, Swampscott, Essex County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Washington Cold Spring, Chelsea, Suffolk County.
Myles Standish Spring, South Duxbury, Plymouth County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Robbins Spring, Arlington, Middlesex County.
Sand Springs, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Sheep Rock Spring, Lowell, Middlesex County.
Simpson Spring, South Easton, Bristol County.
Smiley Spring, Haverhill, Essex County.
Stevens's Spring, Lawrence, Essex County.
Undine Spring, Brighton, Suffolk County.

MICHIGAN.

The total number of springs on the list for Michigan is 23, a gain of 4, that number of new springs being added to the list of 1899. For 1899 sales are reported from 21. They are as follows:

Bromo-Hygeia Mineral Springs, Coldwater, Branch County.
Clarke Mineral Well, Big Rapids, Mecosta County.
Cooper Farm Spring, Birmingham, Oakland County.
Eastman Mineral Springs, Benton Harbor, Berrien County.
Frankfort Springs, Frankfort, Benzie County.
Magnetic Mineral Spring, Spring Lake, Ottawa County.
Medea Spring, Mount Clemens, Macomb County.
Midland Mineral Springs, Midland City, Midland County.
Moorman Springs, Ypsilanti, Washtenaw County.
Mount Clemens Sprudel Water, Mount Clemens, Macomb County.
No-che-mo Mineral Spring, Reed City, Osceola County.
Original Mount Clemens Mineral Spring, Mount Clemens, Macomb County.
Pagoda Spring, Mount Clemens, Macomb County.
Plymouth Rock Well, Plymouth, Wayne County.
Ponce de Leon Springs, Paris Township, Kent County.
Royal Oak Mineral Springs, Royal Oak, Oakland County.
Salutaris Spring, St. Clair Springs, St. Clair County.
Sanator, formerly Americanus Well, Lansing, Ingham County.
Sterling Spring, Crystal Falls, Iron County.
Wurtzel Mineral Springs, Thomastown, near Frost, Saginaw County.
Zauber Wasser Springs, Hudson, Lenawee County.

MINNESOTA.

The list for Minnesota remains as for 1898. Of the 5 springs credited to the State 4 report for 1899. They are the following:

Indian Medical Spring, Elk River, Sherburne County.
Inglewood and Glenwood Springs, Minneapolis, Hennepin County.
Mankato Mineral Springs, near Mankato, Blue Earth County.
Trio Siloam Springs, Austin, Mower County.

MISSISSIPPI.

Mississippi gains one spring. Of the 6 springs now credited to the State all report sales for 1899. They are the following:

Arundel Lithia Springs, near Meridian, Lauderdale County.
Browns Wells, Browns Wells, Copiah County.
Castalian Springs, Durant, Holmes County.
Godbold Mineral Well, Summit, Pike County.
Robinson Mineral Springs, Robinson Springs, Madison County.
Stafford Mineral Springs, near Vosburg, Jasper County.

MISSOURI.

There is a net gain of 2 springs for Missouri, 3 having been added and 1 dropped from the list, making the total 13. All but 1 report sales for 1899. The 12 springs reporting are the following:

American Springs, St. Louis County.
B. B. Mineral Springs, Bowling Green, Pike County.

Blue Lick Springs, Blue Lick, Saline County.
Eldorado Springs, Eldorado Springs, Cedar County.
Excelsior Springs, Excelsior Springs, Clay County.
Lineville Mineral Springs, Mercer County, near Lineville, Iowa.
Livertone Springs, near Bowling Green, Pike County.
McAllister Springs, McAllister, Saline County.
Mulky Springs, Ray County, near Lexington.
Randolph Springs, Randolph Springs, Randolph County.
Sweet Springs, Sweet Springs, Saline County.
Windsor Springs, Windsor, St. Louis County.

MONTANA.

Of the 2 springs credited to Montana only 1 reports sales for 1899, as follows:

Lissner's Mineral Springs, Helena, Lewis and Clarke County.

NEBRASKA.

For 1899 Nebraska, as for several years previously, reports but 1 spring, as follows:

Victoria Mineral Springs, New Helena, Custer County.

NEW HAMPSHIRE.

The total for New Hampshire for 1899 is 6 springs, 3 having been added to the list. All report sales. They are as follows:

Amherst Mineral Spring, Amherst, Hillsboro County.
Gorham Mineral Spring, Gorham, Coos County.
Granite State Spring, Plaistow, Rockingham County.
Lafayette Mineral Spring, Derry, Rockingham County.
Londonderry Lithia Spring, Londonderry, Rockingham County.
Pack Monadnock Lithia Spring, Temple, Hillsboro County.

NEW JERSEY.

New Jersey gains 3 springs, making the total 7 for 1899. Of these all report sales. They are the following:

Beech Springs, near Woodbury, Gloucester County.
Hatawanna Spring, Buddlake, Morris County.
Health Mineral Spring, Woodbury, Gloucester County.
Indian Kalium Spring, Camden, Camden County.
Kalium Springs, Collingswood, Camden County.
Oakland Spring, near Oakland, Bergen County.
Pine Lawn Spring, Hohokus, Bergen County.

NEW MEXICO.

New Mexico's 5 springs all report sales for 1899. They are the following:

Coyote Canyon Springs, Coyote Canyon, Bernalillo County.
Harsch's Iron Springs, Coyote Canyon, Bernalillo County.
Hudson Hot Springs, Hudson, Grant County.
Macbeth Springs, East Las Vegas, San Miguel County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

In the list for New York there is a net gain of 3 springs, 5 new ones being added and 2 dropped, leaving the total at 50. Of these the following 46 report sales for 1899:

Avon Sulphur Spring, Avon, Livingston County.
Ayers Amherst Mineral Springs, near Williamsville, Erie County.
Binghamton Vichy Spring, Binghamton, Broome County.
Boonville Mineral Spring, Boonville, Oneida County.
Cayuga Water, Cayuga, Cayuga County.
Clyde Mineral Spring, Clyde, Wayne County.
Colonial Mineral Spring, West Deer Park, Suffolk County.
Crystal Rock Spring, Fairport, Monroe County.
Deep Rock Spring, Oswego, Oswego County.
Elixir Spring, Clintondale, Ulster County.
Franklin Lithia Springs, Franklin Springs, Oneida County.
Geneva Lithia Mineral Water Spring, Geneva, Ontario County.
Geneva Red Cross Lithia Spring (formerly Chase), Geneva, Ontario County.
Great Bear Spring, near Fulton, Oswego County.
Gurn Spring, Gurnspring, Saratoga County.
Kirkland Mineral Spring, Franklin Iron Works, Oneida County.
Massena Springs, Massena, St. Lawrence County.
Mountain Mist Spring, West Hills, Suffolk County.
Nauroshonk Spring, Nanuet, Rockland County.
Rockdale Mineral Spring, Rockdale, Chenango County.
Saratoga County Artesian Lithia Spring, Ballston Spa, Saratoga County.
Saratoga Springs, Saratoga County:
- Champion Spring.
- Empire Spring.
- Excelsior Spring.
- Geyser Spring.
- Hathorn Spring.
- High Rock Spring.
- Lincoln Spring.
- Old Putnam Mineral Spring.
- Patterson Mineral Spring.
- Quevic Spring.
- Royal Spring.
- Saratoga Arondack (formerly Kissingen) Spring.
- Saratoga Carlsbad Spring.
- Saratoga Star Spring.
- Saratoga Vichy Spring.
- Saratoga Victoria Spring.
- Union Spring.

Split Rock Springs, Franklin Springs, Oneida County.
Table Rock Mineral Spring, Honeoye Falls, Monroe County.
The Vita Spring, Fort Edward, Washington County.
Verona Mineral Springs, Verona, Oneida County.
Victor Mineral Springs, Darien, Genesee County.
Wagner Mineral Spring, Palatine Bridge, Montgomery County.
White Sulphur Springs, Richfield Springs, Otsego County.
White Sulphur Spring, Sharon Springs, Schoharie County.

NORTH CAROLINA.

There is no change in the list for North Carolina. Of the 8 springs credited to the State 7 report sales in 1899. They are the following:

Ashley Bromide and Arsenic Spring, Ashe County.
Barium Rock Spring, Barium Springs, Iredell County.
Lemon Springs, Lemon Springs Station, Moore County.
Panacea Springs, near Littleton, Warren County.
Park Spring, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Thompson Bromine Arsenic Springs, Crumpler, Ashe County.

OHIO.

Ohio has 4 new springs added to the list, making a total of 18 for 1899. Of these 15 report sales. They are the following:

Concord Crystal Spring, Concord, Lake County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Rock Spring, near Sandusky, Erie County.
Fargo Mineral Springs, Ashtabula, Ashtabula County.
Glannaris (formerly Wewoka) Spring, near Toledo, Lucas County.
La Fountaine Springs, Fountain Park, Champaign County.
Mineral Springs, Meigs Township, Adams County.
Oakridge Spring, Greensprings, Sandusky County.
Odovene Spring, Delaware, Delaware County.
Purtlebaugh Mineral Spring, Urbana, Champaign County.
Ripley Bromo-Lithia Springs, Ripley, Brown County.
Rex Ferro-Lithia Springs, New Richmond, Clermont County.
Sulphur Lick Springs, Anderson, Ross County.
Talewanda Mineral Springs, near College Corner, Preble County.
Wheeler's Mineral Springs, Youngstown, Mahoning County.

OREGON.

Of the 3 springs credited to Oregon 2 report their sales for 1899. They are the following:

Siskiyou or Wagner's Mineral Spring, Soda Springs, Jackson County.
Wilhoit Springs, Wilhoit, Clackamas County.

PENNSYLVANIA.

Pennsylvania gains 2 springs, bringing the total up to 30. Of these 25 report their sales for 1899. They are the following:

Bedford Mineral Springs, Bedford, Bedford County.
Black Barren Mineral Spring, Pleasant Grove, Lancaster County.
Buena Vista Springs, Buena Vista, Franklin County.
Charmian Mineral Springs, Charmian, Franklin County.
Cloverdale Artesian Lithia Springs, Newville, Cumberland County.
Corry Artesian Mineral Springs, Corry, Erie County.
Cresson Springs, Cresson, Cambria County.
De Vita Mineral Springs, Cambridge Springs, Crawford County.
East Mountain Lithia Well, near Factoryville, Wyoming County.

Glen Summit Spring, Glen Summit, Luzerne County.
Great Indian Spring, Glen Summit, Luzerne County.
Magnesia Springs, Cambridge Springs, Crawford County.
Pavilion Spring, Wernersville, Berks County.
Petticord Mineral Springs, Cambridge Springs, Crawford County.
Ponce de Leon Mineral Springs, Meadville, Crawford County.
Pulaski Natural Mineral Springs, Pulaski, Lawrence County.
Rennyson Tredyffrin Springs, Rennyson, Chester County.
Roscommon Springs, Windgap, Monroe County.
Saegertown Mineral Spring, Saegertown, Crawford County.
Sizer Mineral Springs, Sizerville, Cameron County.
Springboro Mineral Spring, Springboro, Crawford County.
Susquehanna County Mineral Springs, Rush, Susquehanna County.
The J. W. Lang Mineral Well, Venango, Crawford County.
Tuckahoe Mineral Springs, Northumberland, Northumberland County.
Whann Alkaline Lithia Mineral Springs, near Franklin, Venango County.

RHODE ISLAND.

The list for Rhode Island is increased by 1 spring, the total for 1899 being 5. Of these 4 report sales, as follows:

Gladstone Spring, Naragansett Pier, Washington County.
Holly Mineral Springs, Woonsocket, Providence County.
Ochee Mineral and Medicinal Springs, Johnston, Providence County.
Wakefield Mineral-water Well, Wakefield, Washington County.

SOUTH CAROLINA.

Of the 7 springs credited to South Carolina 5 report their sales for 1899. They are as follows:

Aiken Artesian Well, Aiken, Aiken County.
Bellvue Mineral Spring, Columbia, Richland County.
Chick Springs, near Taylor Station, Greenville County.
Harris Lithia Spring, Waterloo, Laurens County.
Rives Mineral Spring, Lancaster, Lancaster County.

SOUTH DAKOTA.

There is no change in the list for South Dakota, the 2 localities credited to the State both reporting sales for 1899. They are the following:

Hot Springs of South Dakota, Hot Springs, Fall River County.
  Cold Spring.
  Kidney Spring.
  Lakotah Springs.
  Minnekahta Spring.
Minnehaha Springs, Sioux Falls, Minnehaha County.

TENNESSEE.

In Tennessee 1 spring has been dropped and 1 added to the list, leaving the total at 6 as for 1898. They all report sales for 1899, as follows:

Estill Springs, Estill Springs, Franklin County.
Idaho Springs, near Clarksville, Montgomery County.

Red Boiling Springs, Red Boiling Springs, Macon County.
Rhea Springs, Rhea Springs, Rhea County.
Tate Epsom Spring, Tate Spring, Grainger County.
Wright's Epsom Lithia Well, Mooresburg, Hawkins County.

TEXAS.

Texas makes a net gain of 2 springs, 3 being added to the list, while 1 has been dropped. Of the total of 17, sales for 1899 are reported by 15, as follows:

Capp's Wells, Longview, Gregg County.
Dalby Spring, Dalby Springs, Bowie County.
Dullnig Mineral Wells, near San Antonio, Bexar County.
Elkhart Mineral Wells, Elkhart, Anderson County.
Farrier Springs, Dalby Springs, Bowie County.
Georgetown Mineral Well, Georgetown, Williamson County.
High Island Mineral Spring, near Galveston.
Mineral Wells, Mineral Wells, Palo Pinto County.
Overall Mineral Wells, Franklin, Robertson County.
Pal-Pinto Crystal Wells, Palo Pinto County.
Rosborough Springs, near Marshall, Harrison County.
Sour Lake Mineral Springs, Sour Lake, Hardin County.
Sour Springs, near Luling, Caldwell County.
Tioga Mineral Wells, Grayson County.
Wootan Wells, Wootan Wells, Robertson County.

UTAH.

The 3 springs still credited to Utah all report sales for 1899. They are the following:

Castilla Hot Springs, Spanish Fork Canyon, Utah County.
Deseret Lithia-water Springs, Deseret, Millard County.
Wasatka Springs, Salt Lake City, Salt Lake County.

VERMONT.

The total for Vermont is 8 springs, 1 having been added to the list. Reports of sales for 1899 have been received from 6, as follows.

Clarendon Springs, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.
Missisquoi Mineral Springs, Sheldon, Franklin County.
Montvert Spring, Middletown Springs, Rutland County.
Old Sweet Lithia Spring, Hinesburg, Chittenden County.
Vermont Mineral Spring, Putney, Windham County.

VIRGINIA.

Virginia gains 4 springs, her list now having a total of 47. Of these 39 report sales for 1899. They are the following:

Ætna Lithia Springs, Roanoke, Roanoke County.
Bear Lithia Springs, near Elkton, Rockingham County.
Beaufont Lithia Springs, Beaufont, Chesterfield County.

Blue Ridge Springs, Botetourt County.
Buffalo Lithia Springs, Buffalo Lithia Springs, Mecklenburg County.
Chase City Mineral Springs, Chase City, Mecklenburg County.
Colonial Spring, near Claybank Wharf, Gloucester County.
Como Lithia Spring, East Richmond, Henrico County.
Crockett Arsenic Lithia Spring, Shawsville, Montgomery County.
Elk Lithia Springs, Elkton, Rockingham County.
Farmville Lithia Springs, Cumberland County, near Farmville, Prince Edward County.
Fonticello Lithia Spring, Chesterfield County, near Richmond.
Golindo Lithia Springs, Weyers Cave, Augusta County.
Harris Anti-Dyspeptic and Tonic Spring, Burkeville, Nottoway County.
Healing Springs, Healing Springs, Bath County.
Houston Lithia Well, Houston, Halifax County.
Hunter's Pulaski Alum Springs, Walkers Creek, Pulaski County.
Iron Lithia Springs, Tiptop, Tazewell County.
Jeffress Lithia Springs, Jeffress, Mecklenburg County.
Jordan White Sulphur Spring, Stephenson, Frederick County.
Magee's Chlorinated Lithia Springs, Clarksville, Mecklenburg County.
Massanetta Springs, Harrisonburg, Rockingham County.
Nye Lithia Springs, Wytheville, Wythe County.
Otterburn Lithia and Magnesia Springs, Amelia, Amelia County.
Powhatan Lithia and Alum Springs, near Tobaccoville, Powhatan County.
Rawley Springs, near Harrisonburg, Rockingham County.
Roanoke Red Sulphur Springs, Catawba, Roanoke County.
Rockbridge Alum Springs, Alum Springs, Rockbridge County.
Rockingham Virginia Springs, McGaheysville Station, Rockingham County.
Seawright Magnesian Lithia Spring, near Staunton, Augusta County.
Seven Springs, near Glade Spring, Washington County.
Shenandoah Alum Springs, near North Mountain, Shenandoah County.
Stribling Springs, Stribling Springs, Augusta County.
Swineford's Arsenic Lithia Springs, Osceola, Chesterfield County.
Taskinas Springs, Toano, James City County.
Virginia Magnesian Alkaline Springs, near Staunton, Augusta County.
Virginia Waukesha Lithia Springs, Staunton, Augusta County.
Wallawhatoola Alum Springs, near Millboro Spring, Bath County.
Wolf Trap Lithia Springs, Wolf Trap Depot, Halifax County.

WASHINGTON.

There is no change in the list for the State of Washington, the total remaining at 3, and all report sales for 1899. They are the following:

Cascade Springs, near Cascades, Skamania County.
Medical Lake, Medical Lake, Spokane County.
Yakima Soda Springs, west of North Yakima, Yakima County.

WEST VIRGINIA.

Of the 8 springs credited to West Virginia 7 report sales for 1899. They are the following:

Greenbrier Alum Springs, near Lewisburg, Greenbrier County.
Greenbrier White Sulphur Springs, White Sulphur Station, Greenbrier County.
Manacea (formerly Irondale) Spring, Independence, Preston County.

Red Sulphur Springs, Red Sulphur Springs, Monroe County.
Salt Sulphur Springs, Salt Sulphur Springs, Monroe County.
Triplet Well, Calf Creek, Grant District, Pleasants County.
Webster Salt Sulphur Springs, Addison, Webster County.

WISCONSIN.

Wisconsin gains 2 springs, bringing the total up to 37. Of these, 30 report sales for 1899. They are the following:

Allouez Magnesia Springs, Green Bay, Brown County.
Aurelian Spring, Palmyra Springs, Jefferson County.
Bethania Mineral Spring, Farmington, Polk County.
Castalia Springs, Wauwatosa, Milwaukee County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Darlington Mineral Springs, Darlington, Lafayette County.
Fort Crawford Springs, Prairie du Chien, Crawford County.
Lebens Wasser Spring, Green Bay, Brown County.
Nee-Ska-Ra Mineral Spring, Wauwatosa, Milwaukee County.
Rainbow Mineral Spring, Wautoma, Waushara County.
Shealtiel Mineral Spring, Farmington, Waupaca County.
Sheboygan Mineral Spring, Sheboygan, Sheboygan County.
Silver Sand Spring, Milwaukee, Milwaukee County.
Slauson Mineral Spring, Racine, Racine County.
Solon Springs, Upper St. Croix Lake, Douglas County.
Sparkling Spring, Wauwatosa, Milwaukee County.
St. John Mineral Springs, Green Bay, Brown County.
Waukesha Springs, Waukesha County:
- Acme Spring.
- Almanaris Springs.
- Arcadian Spring.
- Bethesda Mineral Spring.
- Clysmic Spring.
- Henk Mineral Spring.
- Horeb Spring.
- Minniska Mineral Spring.
- Siloam Spring.
- Silurian Mineral Spring.
- Sotarian Spring.
- Waukesha Lithia Spring.
- White Rock Mineral Spring.

Summary of reports of mineral springs for 1899.

State or Territory.	Springs reporting.	Springs not reporting.	Total used commercially.
NORTH ATLANTIC STATES.			
Maine	26	0	26
New Hampshire	6	0	6
Vermont	6	2	8
Massachusetts	39	1	40
Rhode Island	4	1	5
Connecticut	12	1	13
New York	46	4	50
New Jersey	7	0	7
Pennsylvania	25	5	30
SOUTH ATLANTIC STATES.			
Delaware	0	0	0
Maryland	11	0	11
District of Columbia	2	0	2
Virginia	39	8	47
West Virginia	7	1	8
North Carolina	7	1	8
South Carolina	5	2	7
Georgia	6	1	7
Florida	2	0	2
SOUTH CENTRAL STATES.			
Kentucky	4	1	5
Tennessee	6	0	6
Alabama	4	0	4
Mississippi	6	0	6
Louisiana	1	0	1
Texas	15	2	17
Indian Territory	0	0	0
Arkansas	5	2	7
Oklahoma	0	0	0
NORTH CENTRAL STATES.			
Ohio	15	3	18
Indiana	12	3	15
Illinois	18	3	21
Michigan	21	2	23
Wisconsin	30	7	37
Minnesota	4	1	5
Iowa	3	3	6

Summary of reports of mineral springs for 1899—Continued.

State or Territory.	Springs reporting.	Springs not reporting.	Total used commercially.
NORTH CENTRAL STATES—continued.			
Missouri	12	1	13
North Dakota	0	0	0
South Dakota	2	0	2
Nebraska	1	0	1
Kansas	6	1	7
WESTERN STATES AND TERRITORIES.			
Alaska	0	0	0
Wyoming	0	0	0
Montana	1	1	2
Colorado	11	2	13
New Mexico	5	0	5
Arizona	0	0	0
Utah	3	0	3
Nevada	0	0	0
Idaho	1	0	1
Washington	3	0	3
Oregon	2	1	3
California	38	2	40
Total	479	62	541

IMPORTS AND EXPORTS.

Prior to the year 1873, as the following tables show, the records of the United States Treasury Department did not distinguish natural and artificial mineral waters. From 1873 to 1883, inclusive, the distinction was made, and artificial mineral waters were classified according to the receptacles in which they were imported. For the period including the years 1884 to 1896 this classification seems to have been dropped, but the artificial waters were still kept separate from the natural waters. Since 1896, however, they have not been differentiated. The number of gallons imported has not varied greatly in the past five years, although for two years the value has increased to some extent.

Mineral waters imported and entered for consumption in the United States, 1867 to 1883, inclusive.

Fiscal year ending June 30—	In bottles of 1 quart or less.		In bottles in excess of 1 quart.	
	Quantity.	Value.	Quantity.	Value.
	Bottles.		*Quarts.*	
1867	370,610	$24,913	3,792	$360
1868	241,702	18,438	22,819	2,052
1869	344,691	25,635	9,739	802
1870	433,212	30,680	18,025	1,743
1871	470,947	34,604	2,320	174
1872	892,913	67,951		
1873	35,508	2,326		
1874	7,238	691		
1875	4,174	471		
1876	25,758	1,899		
1877	12,965	1,328		
1878	8,229	815		
1879	28,440	2,352		
1880	207,554	19,731		
1881	150,326	11,850		
1882	152,277	17,010		
1883	88,497	7,054		

Fiscal year ending June 30—	Not in bottles.		All not artificial.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Gallons.		*Gallons.*		
1867		$137			$25,410
1868	554	104			20,594
1869	1,042	245			26,682
1870	2,063	508			32,931
1871	1,336	141			34,919
1872	639	116			68,067
1873	355	75	394,423	$98,151	100,552
1874	95	16	199,035	79,789	80,496
1875	5	2	395,956	101,640	102,113
1876			447,646	134,889	136,788
1877		22	520,751	167,458	168,808
1878			883,674	350,912	351,727
1879	3	4	798,107	282,153	284,509
1880			927,759	285,798	305,529
1881	55	26	1,225,462	383,616	395,492
1882			1,542,905	410,105	427,115
1883			1,714,085	441,439	448,493

Imports for years 1884 to 1899.

Year ending—	Artificial mineral waters.		Natural mineral waters.	
	Quantity.	Value.	Quantity.	Value.
June 30—	*Gallons.*		*Gallons.*	
1884	29,366	$4,591	1,505,298	$362,651
1885	7,972	2,157	1,660,072	397,875
Dec. 31—				
1886	62,464	16,815	1,618,960	354,242
1887	13,885	4,851	1,915,511	385,906
1888	12,752	4,411	1,716,461	341,695
1889	36,494	8,771	1,558,968	368,661
1890	22,328	7,133	2,322,008	433,281
1891	26,700	8,700	2,019,833	392,894
1892	16,052	9,089	2,266,123	497,660
1893	6,086	2,992	2,321,081	506,866
1894	7,753	3,047	1,891,964	417,500
1895	101,115	19,151	2,104,811	506,384
1896	51,108	11,739	2,273,393	551,097
1897			*a* 2,942,200	*a* 501,684
1898			*a* 1,955,723	*a* 526,071
1899			*a* 2,382,410	*a* 663,803

a Including artificial.

No record seems to have been kept since 1883 of the exports of domestic natural mineral waters, and, as shown by the table below, the exports from 1875 to 1883 were comparatively insignificant.

Exports of natural mineral waters of domestic production from the United States.

Fiscal year ending June 30—	Value.	Fiscal year ending June 30—	Value.
1875	$162	1881	$1,029
1876	80	1882	421
1879	1,529	1883	*a* 459
1880	1,486		

a None reported since 1883.

INDEX.

O

ADVERTISEMENT.

[Twenty-first Annual Report, Part VI—Continued.]

The statute approved March 3, 1879, establishing the United States Geological Survey, contains the following provisions:

"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization; and the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

Except in those cases in which an extra number of any special memoir or report has been supplied to the Survey by resolution of Congress, or has been ordered by the Secretary of the Interior, this office has no copies for gratuitous distribution.

ANNUAL REPORTS.

I. First Annual Report of the United States Geological Survey, by Clarence King. 1880. 8°. 79 pp. 1 map.—A preliminary report describing plan of organization and publications.

II. Second Annual Report of the United States Geological Survey, 1880–'81, by J. W. Powell. 1882. 8°. lv, 588 pp. 62 pl. 1 map.

III. Third Annual Report of the United States Geological Survey, 1881–'82, by J. W. Powell. 1883. 8°. xviii, 564 pp. 67 pl. and maps.

IV. Fourth Annual Report of the United States Geological Survey, 1882–'83, by J. W. Powell. 1884. 8°. xxxii, 473 pp. 85 pl. and maps.

V. Fifth Annual Report of the United States Geological Survey, 1883–'84, by J. W. Powell. 1885. 8°. xxxvi, 469 pp. 58 pl. and maps.

VI. Sixth Annual Report of the United States Geological Survey, 1884–'85, by J. W. Powell. 1885. 8°. xxix, 570 pp. 65 pl. and maps.

VII. Seventh Annual Report of the United States Geological Survey, 1885–'86, by J. W. Powell. 1888. 8°. xx, 656 pp. 71 pl. and maps.

VIII. Eighth Annual Report of the United States Gèological Survey, 1886–'87, by J. W. Powell. 1889. 8°. 2 pt. xix, 474, xii pp., 53 pl. and maps; 1 p. l., 475–1063 pp., 54–76 pl. and maps.

IX. Ninth Annual Report of the United States Geological Survey, 1887–'88, by J. W. Powell. 1889. 8°. xiii, 717 pp. 88 pl. and maps.

X. Tenth Annual Report of the United States Geological Survey, 1888–'89, by J. W. Powell. 1890. 8°. 2 pt. xv, 774 pp., 98 pl. and maps; viii, 123 pp.

XI. Eleventh Annual Report of the United States Geological Survey, 1889–'90, by J. W. Powell. 1891. 8°. 2 pt. xv, 757 pp., 66 pl. and maps; ix, 351 pp., 30 pl.

XII. Twelfth Annual Report of the United States Geological Survey, 1890–'91, by J. W. Powell. 1891. 8°. 2 pt. xiii, 675 pp., 53 pl. and maps; xviii, 576 pp., 146 pl. and maps.

XIII. Thirteenth Annual Report of the United States Geological Survey, 1891–'92, by J. W. Powell. 1893. 8°. 3 pt. vii, 240 pp., 2 maps; x, 372 pp., 105 pl. and maps; xi, 486 pp., 77 pl. and maps.

XIV. Fourteenth Annual Report of the United States Geological Survey, 1892–'93, by J. W. Powell. 1893. 8°. 2 pt. vi, 321 pp., 1 pl.; xx, 597 pp., 74 pl.

XV. Fifteenth Annual Report of the United States Geological Survey, 1893–'94, by J. W. Powell. 1895. 8°. xiv, 755 pp. 48 pl.

XVI. Sixteenth Annual Report of the United States Geological Survey, 1894–'95, Charles D. Walcott, Director. 1895. (Part I, 1896.) 8°. 4 pt. xxii, 910 pp., 117 pl. and maps; xix, 598 pp., 43 pl. and maps; xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl.

XVII. Seventeenth Annual Report of the United States Geological Survey, 1895–'96, Charles D. Walcott, Director. 1896. 8°. 3 pt. in 4 vol. xxii, 1076 pp., 67 pl. and maps; xxv, 864 pp., 113 pl. and maps; xxiii, 542 pp., 8 pl. and maps; iii, 543–1058 pp., 9–13 pl.

XVIII. Eighteenth Annual Report of the United States Geological Survey, 1896–'97, Charles D. Walcott, Director. 1897. (Parts II and III, 1898.) 8°. 5 pt. in 6 vol. 440 pp., 4 pl. and maps; v, 653 pp., 105 pl. and maps; v, 861 pp., 118 pl. and maps; x, 756 pp., 102 pl. and maps; xii, 642 pp., 1 pl.; 643–1400 pp.

XIX. Nineteenth Annual Report of the United States Geological Survey, 1897–'98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 8°. 6 pt. in 7 vol. 422 pp., 2 maps; v, 958 pp., 172 pl. and maps; v, 785 pp., 99 pl. and maps; viii, 814 pp., 118 pl. and maps; xvii, 400 pp., 110 pl. and maps; viii, 651 pp., 11 pl.; viii, 706 pp.

XX. Twentieth Annual Report of the United States Geological Survey, 1898–'99, Charles D. Walcott, Director. 1899. (Parts II, III, IV, V, and VII, 1900.) 8°. 7 pt. in 8 vol. 551 pp., 2 maps; v, 953 pp., 193 pl. and maps; v, 595 pp., 78 pl. and maps; vii, 660 pp., 75 pl. and maps; xix, 498 pp., 159 pl. and maps; viii, 616 pp.; xi, 804 pp., 1 pl.; v, 509 pp., 38 pl. and maps.

XXI. Twenty-first Annual Report of the United States Geological Survey. 1899–1900. Charles D. Walcott, Director. 1900. 8°. 7 pt. in 8 vol.

MONOGRAPHS.

I. Lake Bonneville, by Grove Karl Gilbert. 1890. 4°. xx, 438 pp. 51 pl. 1 map. Price $1.50.

II. Tertiary History of the Grand Cañon District, with Atlas, by Clarence E. Dutton, Capt., U. S. A. 1882. 4°. xiv, 264 pp. 42 pl. and atlas of 24 sheets folio. Price $10.00.

III. Geology of the Comstock Lode and the Washoe District, with Atlas, by George F. Becker. 1882 4°. xv, 422 pp. 7 pl. and atlas of 21 sheets folio. Price $11.00.

IV. Comstock Mining and Miners, by Eliot Lord. 1883. 4°. xiv, 451 pp. 3 pl. Price $1.50.

V. The Copper-Bearing Rocks of Lake Superior, by Roland Duer Irving. 1883. 4°. xvi, 464 pp. 15 l. 29 pl. and maps. Price $1.85.

VI. Contributions to the Knowledge of the Older Mesozoic Flora of Virginia, by William Morris Fontaine. 1883. 4°. xi, 144 pp. 54 l. 54 pl. Price $1.05.

VII. Silver-Lead Deposits of Eureka, Nevada, by Joseph Story Curtis. 1884. 4°. xiii, 200 pp. 16 pl. Price $1.20.

VIII. Paleontology of the Eureka District, by Charles Doolittle Walcott. 1884. 4°. xiii, 298 pp. 24 l. 24 pl. Price $1.10.

IX. Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey, by Robert P. Whitfield. 1885. 4°. xx, 338 pp. 35 pl. 1 map. Price $1.15.

X. Dinocerata: A Monograph of an Extinct Order of Gigantic Mammals, by Othniel Charles Marsh. 1886. 4°. xviii, 243 pp. 56 l. 56 pl. Price $2.70.

XI. Geological History of Lake Lahontan, a Quaternary Lake of Northwestern Nevada, by Israel Cook Russell. 1885. 4°. xiv, 288 pp. 46 pl. and maps. Price $1.75.

XII. Geology and Mining Industry of Leadville, Colorado, with Atlas, by Samuel Franklin Emmons. 1886. 4°. xxix, 770 pp. 45 pl. and atlas of 35 sheets folio. Price $8.40.

XIII. Geology of the Quicksilver Deposits of the Pacific Slope, with Atlas, by George F. Becker. 1888. 4°. xix, 486 pp. 7 pl. and atlas of 14 sheets folio. Price $2.00.

XIV. Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, by John S. Newberry. 1888. 4°. xiv, 152 pp. 26 pl. Price $1.00.

XV. The Potomac or Younger Mesozoic Flora, by William Morris Fontaine. 1889. 4°. xiv, 377 pp. 180 pl. Text and plates bound separately. Price $2.50.

XVI. The Paleozoic Fishes of North America, by John Strong Newberry. 1889. 4°. 340 pp. 53 pl. Price $1.00.

XVII. The Flora of the Dakota Group, a Posthumous Work, by Leo Lesquereux. Edited by F. H. Knowlton. 1891. 4°. 400 pp. 66 pl. Price $1.10.

XVIII. Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey, by Robert P. Whitfield. 1891. 4°. 402 pp. 50 pl. Price $1.00.

XIX. The Penokee Iron-Bearing Series of Northern Wisconsin and Michigan, by Roland D. Irving and C. R. Van Hise. 1892. 4°. xix, 534 pp. 37 pl. Price $1.70.

XX. Geology of the Eureka District, Nevada, with Atlas, by Arnold Hague. 1892. 4°. xvii, 419 pp. 8 pl. Price $5.25.

XXI. The Tertiary Rhynchophorous Coleoptera of North America, by Samuel Hubbard Scudder. 1893. 4°. xi, 206 pp. 18 pl. Price 90 cents.

XXII. A Manual of Topographic Methods, by Henry Gannett, Chief Topographer. 1893. 4°. xiv, 300 pp. 18 pl. Price $1.00.

XXIII. Geology of the Green Mountains in Massachusetts, by Raphael Pumpelly, J. E. Wolff, and T. Nelson Dale. 1894. 4°. xiv, 206 pp. 23 pl. Price $1.30.

XXIV. Mollusca and Crustacea of the Miocene Formations of New Jersey, by Robert Parr Whitfield. 1894. 4°. 195 pp. 24 pl. Price 90 cents.

XXV. The Glacial Lake Agassiz, by Warren Upham. 1895. 4°. xxiv, 658 pp. 38 pl. Price $1.70.

XXVI. Flora of the Amboy Clays, by John Strong Newberry; a Posthumous Work, edited by Arthur Hollick. 1895. 4°. 260 pp. 58 pl. Price $1.00.

XXVII. Geology of the Denver Basin, Colorado, by S. F. Emmons, Whitman Cross, and George H. Eldridge. 1896. 4°. 556 pp. 31 pl. Price $1.50.

XXVIII. The Marquette Iron-Bearing District of Michigan, with Atlas, by C. R. Van Hise and W. S. Bayley, including a Chapter on the Republic Trough, by H. L. Smyth. 1897. 4°. 608 pp. 35 pl. and atlas of 39 sheets folio. Price $5.75.

XXIX. Geology of Old Hampshire County, Massachusetts, comprising Franklin, Hampshire, and Hampden Counties, by Benjamin Kendall Emerson. 1898. 4°. xxi, 790 pp. 35 pl. Price $1.90.

XXX. Fossil Medusæ, by Charles Doolittle Walcott. 1898. 4°. ix, 201 pp. 47 pl. Price $1.50.

XXXI. Geology of the Aspen Mining District, Colorado, with Atlas, by Josiah Edward Spurr. 1898. 4°. xxxv, 260 pp. 43 pl. and atlas of 30 sheets folio. Price $3.60.

XXXII. Geology of the Yellowstone National Park, Part II, Descriptive Geology, Petrography, and Paleontology, by Arnold Hague, J. P. Iddings, W. Harvey Weed, Charles D. Walcott, G. H. Girty, T. W. Stanton, and F. H. Knowlton. 1899. 4°. xvii, 893 pp. 121 pl. Price $2.45.

XXXIII. Geology of the Narragansett Basin, by N. S. Shaler, J. B. Woodworth, and August F. Foerste. 1899. 4°. xx, 402 pp. 31 pl. Price $1.

XXXIV. The Glacial Gravels of Maine and their Associated Deposits, by George H. Stone. 1899. 4°. xiii, 499 pp. 52 pl. Price $1.30.

XXXV. The Later Extinct Floras of North America, by John Strong Newberry; edited by Arthur Hollick. 1898. 4°. xviii, 295 pp. 68 pl. Price $1.25.

XXXVI. The Crystal Falls Iron-Bearing District of Michigan, by J. Morgan Clements and Henry Lloyd Smyth; with a Chapter on the Sturgeon River Tongue, by William Shirley Bayley, and an Introduction by Charles Richard Van Hise. 1899. 4°. xxxvi, 512 pp. 53 pl. Price $2.

XXXVII. Fossil Flora of the Lower Coal Measures of Missouri, by David White. 1899. 4°. xi, 467 pp. 73 pl. Price $1.25.

XXXVIII. The Illinois Glacial Lobe, by Frank Leverett. 1899. 4°. xxi, 817 pp. 24 pl. Price $1.60.

XXXIX. The Eocene and Lower Oligocene Coral Faunas of the United States, with Descriptions of a Few Doubtfully Cretaceous Species, by T. Wayland Vaughan. 1900. 4°. 263 pp. 24 pl. Price $1.10.

XL. Adephagous and Clavicorn Coleoptera from the Tertiary Deposits at Florissant, Colorado, with Descriptions of a Few Other Forms and a Systematic List of the Non-Rhyncophorous Tertiary Coleoptera of North America, by Samuel Hubbard Scudder. 1900. 4°. 148 pp. 11 pl. Price 80 cents.

In preparation:

— Flora of the Laramie and Allied Formations, by Frank Hall Knowlton.

— Glacial Formations and Drainage Features of the Erie and Ohio Basins, by Frank Leverett.

BULLETINS.

1. On Hypersthene-Andesite and on Triclinic Pyroxene in Augitic Rocks, by Whitman Cross, with a Geological Sketch of Buffalo Peaks, Colorado, by S. F. Emmons. 1883. 8°. 42 pp. 2 pl. Price 10 cents.

2. Gold and Silver Conversion Tables, giving the Coining Value of Troy Ounces of Fine Metal, etc., computed by Albert Williams, jr. 1883. 8°. 8 pp. Price 5 cents.

3. On the Fossil Faunas of the Upper Devonian, along the Meridian of 76° 30′, from Tompkins County, New York, to Bradford County, Pennsylvania, by Henry S. Williams. 1884. 8°. 36 pp. Price 5 cents.

4. On Mesozoic Fossils, by Charles A. White. 1884. 8°. 36 pp. 9 pl. Price 5 cents.

5. A Dictionary of Altitudes in the United States, compiled by Henry Gannett. 1884. 8°. 325 pp. Price 20 cents.

6. Elevations in the Dominion of Canada, by J. W. Spencer. 1884. 8°. 43 pp. Price 5 cents.

7. Mapoteca Geologica Americana: A Catalogue of Geological Maps of America (North and South), 1752–1881, in Geographic and Chronologic Order, by Jules Marcou and John Belknap Marcou. 1884. 8°. 184 pp. Price 10 cents.

8. On Secondary Enlargements of Mineral Fragments in Certain Rocks, by R. D. Irving and C. R. Van Hise. 1884. 8°. 56 pp. 6 pl. Price 10 cents.

9. A Report of Work done in the Washington Laboratory during the Fiscal Year 1883–'84. F. W. Clarke, Chief Chemist. T. M. Chatard, Assistant Chemist. 1884. 8°. 40 pp. Price 5 cents.

10. On the Cambrian Faunas of North America. Preliminary Studies, by Charles Doolittle Walcott. 1884. 8°. 74 pp. 10 pl. Price 5 cents.

11. On the Quaternary and Recent Mollusca of the Great Basin, with Descriptions of New Forms, by R. Ellsworth Call. Introduced by a Sketch of the Quaternary Lakes of the Great Basin, by G. K. Gilbert. 1884. 8°. 66 pp. 6 pl. Price 5 cents.

12. A Crystallographic Study of the Thinolite of Lake Lahontan, by Edward S. Dana. 1884. 8°. 34 pp. 3 pl. Price 5 cents.

13. Boundaries of the United States and of the Several States and Territories, with a Historical Sketch of the Territorial Changes, by Henry Gannett. 1885. 8°. 135 pp. Price 10 cents. (Exhausted.)

14. The Electrical and Magnetic Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1885. 8°. 238 pp. Price 15 cents.

15. On the Mesozoic and Cenozoic Paleontology of California, by Charles A. White. 1885. 8°. 33 pp. Price 5 cents.

16. On the Higher Devonian Faunas of Ontario County, New York, by John M. Clarke. 1885. 8°. 86 pp. 3 pl. Price 5 cents.

17. On the Development of Crystallization in the Igneous Rocks of Washoe, Nevada, with notes on the Geology of the District, by Arnold Hague and Joseph P. Iddings. 1885. 8°. 44 pp. Price 5 cents.

18. On Marine Eocene, Fresh-Water Miocene, and Other Fossil Mollusca of Western North America, by Charles A. White. 1885. 8°. 26 pp. 3 pl. Price 5 cents.

19. Notes on the Stratigraphy of California, by George F. Becker. 1885. 8°. 28 pp. Price 5 cents. (Exhausted.)

20. Contributions to the Mineralogy of the Rocky Mountains, by Whitman Cross and W. F. Hillebrand. 1885. 8°. 114 pp. 1 pl. Price 10 cents.

21. The Lignites of the Great Sioux Reservation. A Report on the Region between the Grand and Moreau Rivers, Dakota, by Bailey Willis. 1885. 8°. 16 pp. 5 pl. Price 5 cents.

22. On New Cretaceous Fossils from California, by Charles A. White. 1885. 8°. 25 pp. 5 pl. Price 5 cents.

23. Observations on the Junction between the Eastern Sandstone and the Keweenaw Series on Keweenaw Point, Lake Superior, by R. D. Irving and T. C. Chamberlin. 1885. 8°. 124 pp. 17 pl. Price 15 cents.

24. List of Marine Mollusca, comprising the Quaternary Fossils and Recent Forms from American Localities between Cape Hatteras and Cape Roque, including the Bermudas, by William Healy Dall 1885. 8°. 336 pp. Price 25 cents.

25. The Present Technical Condition of the Steel Industry of the United States, by Phineas Barnes. 1885. 8°. 85 pp. Price 10 cents.

26. Copper Smelting, by Henry M. Howe. 1885. 8°. 107 pp. Price 10 cents.

27. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1884–'85. 1886. 8°. 80 pp. Price 10 cents.

28. The Gabbros and Associated Hornblende Rocks occurring in the Neighborhood of Baltimore, Maryland, by George Huntington Williams. 1886. 8°. 78 pp. 4 pl. Price 10 cents.

29. On the Fresh-Water Invertebrates of the North American Jurassic, by Charles A. White. 1886. 8°. 41 pp. 4 pl. Price 5 cents.

30. Second Contribution to the Studies on the Cambrian Faunas of North America, by Charles Doolittle Walcott. 1886. 8°. 369 pp. 33 pl. Price 25 cents.

31. Systematic Review of our Present Knowledge of Fossil Insects, including Myriapods and Arachnids, by Samuel Hubbard Scudder. 1886. 8°. 128 pp. Price 15 cents.

32. Lists and Analyses of the Mineral Springs of the United States (a Preliminary Study), by Albert C. Peale. 1886. 8°. 235 pp. Price 20 cents.

33. Notes on the Geology of Northern California, by J. S. Diller. 1886. 8°. 23 pp. Price 5 cents.

34. On the Relation of the Laramie Molluscan Fauna to that of the Succeeding Fresh-Water Eocene and Other Groups, by Charles A. White. 1886. 8°. 54 pp. 5 pl. Price 10 cents.

35. Physical Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1886. 8°. 62 pp. Price 10 cents.

36. Subsidence of Fine Solid Particles in Liquids, by Carl Barus. 1886. 8°. 58 pp. Price 10 cents.

37. Types of the Laramie Flora, by Lester F. Ward. 1887. 8°. 354 pp. 57 pl. Price 25 cents.

38. Peridotite of Elliott County, Kentucky, by J. S. Diller. 1887. 8°. 31 pp. 1 pl. Price 5 cents.

39. The Upper Beaches and Deltas of the Glacial Lake Agassiz, by Warren Upham. 1887. 8°. 84 pp. 1 pl. Price 10 cents.

40. Changes in River Courses in Washington Territory due to Glaciation, by Bailey Willis. 1887. 8°. 10 pp. 4 pl. Price 5 cents.

41. On the Fossil Faunas of the Upper Devonian—the Genesee Section, New York, by Henry S. Williams. 1887. 8°. 121 pp. 4 pl. Price 15 cents.

42. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1885–'86. F. W. Clarke, Chief Chemist. 1887. 8°. 152 pp. 1 pl. Price 15 cents.

43. Tertiary and Cretaceous Strata of the Tuscaloosa, Tombigbee, and Alabama Rivers, by Eugene A. Smith and Lawrence C. Johnson. 1887. 8°. 189 pp. 21 pl. Price 15 cents.

44. Bibliography of North American Geology for 1886, by Nelson H. Darton. 1887. 8°. 35 pp. Price 5 cents.

45. The Present Condition of Knowledge of the Geology of Texas, by Robert T. Hill. 1887. 8°. 94 pp. Price 10 cents.

46. Nature and Origin of Deposits of Phosphate of Lime, by R. A. F. Penrose, jr., with an Introduction by N. S. Shaler. 1888. 8°. 143 pp. Price 15 cents.

47. Analyses of Waters of the Yellowstone National Park, with an Account of the Methods of Analysis employed, by Frank Austin Gooch and James Edward Whitfield. 1888. 8°. 84 pp. Price 10 cents.

48. On the Form and Position of the Sea Level, by Robert Simpson Woodward. 1888. 8°. 88 pp. Price 10 cents.

49. Latitudes and Longitudes of Certain Points in Missouri, Kansas, and New Mexico, by Robert Simpson Woodward. 1889. 8°. 133 pp. Price 15 cents.

50. Formulas and Tables to facilitate the Construction and Use of Maps, by Robert Simpson Woodward. 1889. 8°. 124 pp. Price 15 cents.

51. On Invertebrate Fossils from the Pacific Coast, by Charles Abiathar White. 1889. 8°. 102 pp. 14 pl. Price 15 cents.

52. Subaërial Decay of Rocks and Origin of the Red Color of Certain Formations, by Israel Cook Russell. 1889. 8°. 65 pp. 5 pl. Price 10 cents.

53. The Geology of Nantucket, by Nathaniel Southgate Shaler. 1889. 8°. 55 pp. 10 pl. Price 10 cents.

54. On the Thermo-Electric Measurement of High Temperatures, by Carl Barus. 1889. 8°. 313 pp. incl. 1 pl. 11 pl. Price 25 cents.

55. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1886–'87. Frank Wigglesworth Clarke, Chief Chemist. 1889. 8°. 96 pp. Price 10 cents.

56. Fossil Wood and Lignite of the Potomac Formation, by Frank Hall Knowlton. 1889. 8°. 72 pp. 7 pl. Price 10 cents.

57. A Geological Reconnoissance in Southwestern Kansas, by Robert Hay. 1890. 8°. 49 pp. 2 pl. Price 5 cents.

58. The Glacial Boundary in Western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois, by George Frederick Wright, with an Introduction by Thomas Chrowder Chamberlin. 1890. 8°. 112 pp. 8 pl. Price 15 cents.

59. The Gabbros and Associated Rocks in Delaware, by Frederick D. Chester. 1890. 8°. 45 pp. 1 pl. Price 10 cents.

60. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1887–'88. F. W. Clarke, Chief Chemist. 1890. 8°. 174 pp. Price 15 cents.

61. Contributions to the Mineralogy of the Pacific Coast, by William Harlow Melville and Waldemar Lindgren. 1890. 8°. 40 pp. 3 pl. Price 5 cents.

62. The Greenstone Schist Areas of the Menominee and Marquette Regions of Michigan; a Contribution to the Subject of Dynamic Metamorphism in Eruptive Rocks, by George Huntington Williams; with an Introduction by Roland Duer Irving. 1890. 8°. 241 pp. 16 pl. Price 30 cents.

63. A Bibliography of Paleozoic Crustacea from 1698 to 1889, including a List of North American Species and a Systematic Arrangement of Genera, by Anthony W. Vogdes. 1890. 8°. 177 pp. Price 15 cents.

64. A report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1888–'89. F. W. Clarke, Chief Chemist. 1890. 8°. 60 pp. Price 10 cents.

65. Stratigraphy of the Bituminous Coal Field of Pennsylvania, Ohio, and West Virginia, by Israel C. White. 1891. 8°. 212 pp. 11 pl. Price 20 cents. (Exhausted.)

66. On a Group of Volcanic Rocks from the Tewan Mountains, New Mexico, and on the Occurrence of Primary Quartz in Certain Basalts, by Joseph Paxson Iddings. 1890. 8°. 34 pp. Price 5 cents.

67. The Relations of the Traps of the Newark System in the New Jersey Region, by Nelson Horatio Darton. 1890. 8°. 82 pp. Price 10 cents.

68. Earthquakes in California in 1889, by James Edward Keeler. 1890. 8°. 25 pp. Price 5 cents.

69. A Classed and Annotated Bibliography of Fossil Insects, by Samuel Hubbard Scudder. 1890. 8°. 101 pp. Price 15 cents.

70. Report on Astronomical Work of 1889 and 1890, by Robert Simpson Woodward. 1890. 8°. 79 pp. Price 10 cents.

71. Index to the Known Fossil Insects of the World, including Myriapods and Arachnids, by Samuel Hubbard Scudder. 1891. 8°. 744 pp. Price 50 cents.

72. Altitudes between Lake Superior and the Rocky Mountains, by Warren Upham. 1891. 8°. 229 pp. Price 20 cents.

73. The Viscosity of Solids, by Carl Barus. 1891. 8°. xii, 139 pp. 6 pl. Price 15 cents.

74. The Minerals of North Carolina, by Frederick Augustus Genth. 1891. 8°. 119 pp. Price 15 cents.

75. Record of North American Geology for 1887 to 1889, inclusive, by Nelson Horatio Darton. 1891. 8°. 173 pp. Price 15 cents.

76. A Dictionary of Altitudes in the United States (Second Edition), compiled by Henry Gannett, Chief Topographer. 1891. 8°. 393 pp. Price 25 cents.

77. The Texan Permian and its Mesozoic Types of Fossils, by Charles A. White. 1891. 8°. 51 pp. 4 pl. Price 10 cents.

78. A Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1889–'90. F. W. Clarke, Chief Chemist. 1891. 8°. 131 pp. Price 15 cents.

79. A Late Volcanic Eruption in Northern California and its Peculiar Lava, by J. S. Diller. 1891. 8°. 33 pp. 17 pl. Price 10 cents.

80. Correlation Papers—Devonian and Carboniferous, by Henry Shaler Williams. 1891. 8°. 279 pp. Price 20 cents.

81. Correlation Papers—Cambrian, by Charles Doolittle Walcott. 1891. 8°. 447 pp. 3 pl. Price 25 cents. (Exhausted.)

82. Correlation Papers—Cretaceous, by Charles A. White. 1891. 8°. 273 pp. 3 pl. Price 20 cents.

83. Correlation Papers—Eocene, by William Bullock Clark. 1891. 8°. 173 pp. 2 pl. Price 15 cents.

84. Correlation Papers—Neocene, by W. H. Dall and G. D. Harris. 1892. 8°. 349 pp. 3 pl. Price 25 cents.

85. Correlation Papers—The Newark System, by Israel Cook Russell. 1892. 8°. 344 pp. 13 pl. Price 25 cents.

86. Correlation Papers—Archean and Algonkian, by C. R. Van Hise. 1892. 8°. 549 pp. 12 pl. Price 25 cents. (Exhausted.)

87. A Synopsis of American Fossil Brachiopoda, including Bibliography and Synonymy, by Charles Schuchert. 1897. 8°. 464 pp. Price 25 cents.

88. The Cretaceous Foraminifera of New Jersey, by Rufus Mather Bagg, jr. 1898. 8°. 89 pp. 6 pl. Price 10 cents.

89. Some Lava Flows of the Western Slope of the Sierra Nevada, California, by F. Leslie Ransome. 1898. 8°. 74 pp. 11 pl. Price 15 cents.

90. A Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1890–'91. F. W. Clarke, Chief Chemist. 1892. 8°. 77 pp. Price 10 cents.

91. Record of North American Geology for 1890, by Nelson Horatio Darton. 1891. 8°. 88 pp. Price 10 cents.

92. The Compressibility of Liquids, by Carl Barus. 1892. 8°. 96 pp. 29 pl. Price 10 cents.

93. Some Insects of Special Interest from Florissant, Colorado, and Other Points in the Tertiaries of Colorado and Utah, by Samuel Hubbard Scudder. 1892. 8°. 35 pp. 3 pl. Price 5 cents.

94. The Mechanism of Solid Viscosity, by Carl Barus. 1892. 8°. 138 pp. Price 15 cents.

95. Earthquakes in California in 1890 and 1891, by Edward Singleton Holden. 1892. 8° 31 pp. Price 5 cents.

96. The Volume Thermodynamics of Liquids, by Carl Barus. 1892. 8°. 100 pp. Price 10 cents.

97. The Mesozoic Echinodermata of the United States, by William Bullock Clark. 1893. 8°. 207 pp. 50 pl. Price 20 cents.

98. Flora of the Outlying Carboniferous Basins of Southwestern Missouri, by David White. 1893. 8°. 139 pp. 5 pl. Price 15 cents.

99. Record of North American Geology for 1891, by Nelson Horatio Darton. 1892. 8°. 73 pp. Price 10 cents.

100. Bibliography and Index of the Publications of the U. S. Geological Survey, 1879–1892, by Philip Creveling Warman. 1893. 8°. 495 pp. Price 25 cents.

101. Insect Fauna of the Rhode Island Coal Field, by Samuel Hubbard Scudder. 1893. 8°. 27 pp. 2 pl. Price 5 cents.

102. A Catalogue and Bibliography of North American Mesozoic Invertebrata, by Cornelius Breckinridge Boyle. 1893. 8°. 315 pp. Price 25 cents.

103. High Temperature Work in Igneous Fusion and Ebullition, chiefly in Relation to Pressure, by Carl Barus. 1893. 8°. 57 pp. 9 pl. Price 10 cents.

104. Glaciation of the Yellowstone Valley north of the Park, by Walter Harvey Weed. 1893. 8°. 41 pp. 4 pl. Price 5 cents.

105. The Laramie and the Overlying Livingston Formation in Montana, by Walter Harvey Weed, with Report on Flora, by Frank Hall Knowlton. 1893. 8°. 68 pp. 6 pl. Price 10 cents.

106. The Colorado Formation and its Invertebrate Fauna, by T. W. Stanton. 1893. 8°. 288 pp. 45 pl. Price 20 cents.

107. The Trap Dikes of the Lake Champlain Region, by James Furman Kemp and Vernon Freeman Marsters. 1893. 8°. 62 pp. 4 pl. Price 10 cents.

108. A Geological Reconnoissance in Central Washington, by Israel Cook Russell. 1893. 8°. 108 pp. 12 pl. Price 15 cents.

109. The Eruptive and Sedimentary Rocks on Pigeon Point, Minnesota, and their Contact Phenomena, by William Shirley Bayley. 1893. 8°. 121 pp. 16 pl. Price 15 cents.

110. The Paleozoic Section in the Vicinity of Three Forks, Montana, by Albert Charles Peale. 1893. 8°. 56 pp. 6 pl. Price 10 cents.

111. Geology of the Big Stone Gap Coal Field of Virginia and Kentucky, by Marius R. Campbell. 1893. 8°. 106 pp. 6 pl. Price 15 cents.

112. Earthquakes in California in 1892, by Charles D. Perrine. 1893. 8°. 57 pp. Price 10 cents.

113. A Report of Work done in the Division of Chemistry during the Fiscal Years 1891–'92 and 1892–'93. F. W. Clarke, Chief Chemist. 1893. 8°. 115 pp. Price 15 cents.

114. Earthquakes in California in 1893, by Charles D. Perrine. 1894. 8°. 23 pp. Price 5 cents.

115. A Geographic Dictionary of Rhode Island, by Henry Gannett. 1894. 8°. 31 pp. Price 5 cents.

116. A Geographic Dictionary of Massachusetts, by Henry Gannett. 1894. 8°. 126 pp. Price 15 cents.

117. A Geographic Dictionary of Connecticut, by Henry Gannett. 1894. 8°. 67 pp. Price 10 cents.

118. A Geographic Dictionary of New Jersey, by Henry Gannett. 1894. 8°. 131 pp. Price 15 cents.

119. A Geological Reconnoissance in Northwest Wyoming, by George Homans Eldridge. 1894. 8°. 72 pp. 4 pl. Price 10 cents.

120. The Devonian System of Eastern Pennsylvania and New York, by Charles S. Prosser. 1895. 8°. 81 pp. 2 pl. Price 10 cents.

121. A Bibliography of North American Paleontology, by Charles Rollin Keyes. 1894. 8°. 251 pp. Price 20 cents.

122. Results of Primary Triangulation, by Henry Gannett. 1894. 8°. 412 pp. 17 pl. Price 25 cents.

123. A Dictionary of Geographic Positions, by Henry Gannett. 1895. 8°. 183 pp. 1 pl. Price 15 cents.

124. Revision of North American Fossil Cockroaches, by Samuel Hubbard Scudder. 1895. 8°. 176 pp. 12 pl. Price 15 cents.

125. The Constitution of the Silicates, by Frank Wigglesworth Clarke. 1895. 8°. 109 pp. Price 15 cents.

126. A Mineralogical Lexicon of Franklin, Hampshire, and Hampden Counties, Massachusetts, by Benjamin Kendall Emerson. 1895. 8°. 180 pp. 1 pl. Price 15 cents.

127. Catalogue and Index of Contributions to North American Geology, 1732–1891, by Nelson Horatio Darton. 1896. 8°. 1045 pp. Price 60 cents.

128. The Bear River Formation and its Characteristic Fauna, by Charles A. White. 1895. 8°. 108 pp. 11 pl. Price 15 cents.

129. Earthquakes in California in 1894, by Charles D. Perrine. 1895. 8°. 25 pp. Price 5 cents.

130. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for 1892 and 1893, by Fred Boughton Weeks. 1896. 8°. 210 pp. Price 20 cents.

131. Report of Progress of the Division of Hydrography for the Calendar Years 1893 and 1894, by Frederick Haynes Newell, Topographer in Charge. 1895. 8°. 126 pp. Price 15 cents.

132. The Disseminated Lead Ores of Southeastern Missouri, by Arthur Winslow. 1896. 8°. 31 pp. Price 5 cents.

133. Contributions to the Cretaceous Paleontology of the Pacific Coast: The Fauna of the Knoxville Beds, by T. W. Stanton. 1895. 8°. 132 pp. 20 pl. Price 15 cents.

134. The Cambrian Rocks of Pennsylvania, by Charles Doolittle Walcott. 1896. 8°. 43 pp. 15 pl. Price 5 cents.

135. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1894, by F. B. Weeks. 1896. 8°. 141 pp. Price 15 cents.

136. Volcanic Rocks of South Mountain, Pennsylvania, by Florence Bascom. 1896. 8°. 124 pp. 28 pl. Price 15 cents.

137. The Geology of the Fort Riley Military Reservation and Vicinity, Kansas, by Robert Hay. 1896. 8°. 35 pp. 8 pl. Price 5 cents.

138. Artesian-Well Prospects in the Atlantic Coastal Plain Region, by N. H. Darton. 1896. 8°. 228 pp. 19 pl. Price 20 cents.

139. Geology of the Castle Mountain Mining District, Montana, by W. H. Weed and L. V. Pirsson. 1896. 8°. 164 pp. 17 pl. Price 15 cents.

140. Report of Progress of the Division of Hydrography for the Calendar Year 1895, by Frederick Haynes Newell, Hydrographer in Charge. 1896. 8°. 356 pp. Price 25 cents.

141. The Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland, and Virginia, by William Bullock Clark. 1896. 8°. 167 pp. 40 pl. Price 15 cents.

142. A Brief Contribution to the Geology and Paleontology of Northwestern Louisiana, by T. Wayland Vaughan. 1896. 8°. 65 pp. 4 pl. Price 10 cents.

143. A Bibliography of Clays and the Ceramic Arts, by John C. Branner. 1896. 8°. 114 pp. Price 15 cents.

144. The Moraines of the Missouri Coteau and their Attendant Deposits, by James Edward Todd. 1896. 8°. 71 pp. 21 pl. Price 10 cents.

145. The Potomac Formation in Virginia, by W. M. Fontaine. 1896. 8°. 149 pp. 2 pl. Price 15 cents.

146. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1895, by F. B. Weeks. 1896. 8°. 130 pp. Price 15 cents.

147. Earthquakes in California in 1895, by Charles D. Perrine, Assistant Astronomer in Charge of Earthquake Observations at the Lick Observatory. 1896. 8°. 23 pp. Price 5 cents.

148. Analyses of Rocks, with a Chapter on Analytical Methods, Laboratory of the United States Geological Survey, 1880 to 1896, by F.W. Clarke and W. F. Hillebrand. 1897. 8°. 306 pp. Price 20 cents.

149. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1896, by Fred Boughton Weeks. 1897. 8°. 152 pp. Price 15 cents.

150. The Educational Series of Rock Specimens Collected and Distributed by the United States Geological Survey, by Joseph Silas Diller. 1898. 8°. 400 pp. 47 pl. Price 25 cents.

151. The Lower Cretaceous Gryphæas of the Texas Region, by R. T. Hill and T. Wayland Vaughan. 1898. 8°. 139 pp. 35 pl. Price 15 cents.

152. A Catalogue of the Cretaceous and Tertiary Plants of North America, by F. H. Knowlton. 1898. 8°. 247 pp. Price 20 cents.

153. A Bibliographic Index of North American Carboniferous Invertebrates, by Stuart Weller. 1898. 8°. 653 pp. Price 35 cents.

154. A Gazetteer of Kansas, by Henry Gannett. 1898. 8°. 246 pp. 6 pl. Price 20 cents.

155. Earthquakes in California in 1896 and 1897, by Charles D. Perrine, Assistant Astronomer in Charge of Earthquake Observations at the Lick Observatory. 1898. 8°. 47 pp. Price 5 cents.

156. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1897, by Fred Boughton Weeks. 1898. 8°. 130 pp. Price 15 cents.

157. The Gneisses, Gabbro-Schists, and Associated Rocks of Southwestern Minnesota, by Christopher Webber Hall. 1899. 8°. 160 pp. 27 pl. Price 45 cents.

158. The Moraines of Southeastern South Dakota and their Attendant Deposits, by James Edward Todd. 1899. 8°. 171 pp. 27 pl. Price 25 cents.

159. The Geology of Eastern Berkshire County, Massachusetts, by B. K. Emerson. 1899. 8°. 139 pp. 9 pl. Price 20 cents.

160. A Dictionary of Altitudes in the United States (Third Edition), compiled by Henry Gannett. 1899. 8°. 775 pp. Price 40 cents.

161. Earthquakes in California in 1898, by Charles D. Perrine, Assistant Astronomer in Charge of Earthquake Observations at the Lick Observatory. 1899. 8°. 31 pp. 1 pl. Price 5 cents.

162. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1898, by Fred Boughton Weeks. 1899. 8°. 163 pp. Price 15 cents.

163. Flora of the Montana Formation, by Frank Hall Knowlton. 1900. 8°. 118 pp. 19 pl. Price 15 cents

164. Reconnaissance in the Rio Grande Coal Fields of Texas, by Thomas Wayland Vaughan, including a Report on Igneous Rocks from the San Carlos Coal Field, by E. C. E. Lord. 1900. 8°. 100 pp. 11 pl. and maps. Price 20 cents.

165. Contributions to the Geology of Maine, by Henry S. Williams and Herbert E. Gregory. 1900. 8°. 212 pp. 14 pl. Price 25 cents.

166. A Gazetteer of Utah, by Henry Gannett. 1900. 8°. 43 pp. 1 map. Price 15 cents.

167. Contributions to Chemistry and Mineralogy from the Laboratory of the United States Geological Survey; Frank W. Clarke, Chief Chemist. 1900. 8°. 166 pp. Price 15 cents.

168. Analyses of Rocks, Laboratory of the United States Geological Survey, 1880 to 1899, tabulated by F. W. Clarke, Chief Chemist. 1900. 8°. 308 pp. Price 20 cents.

169. Altitudes in Alaska, by Henry Gannett. 1900. 8°. 13 pp. Price 5 cents.

170. Survey of the Boundary Line between Idaho and Montana from the International Boundary to the Crest of the Bitterroot Mountains, by Richard Urquhart Goode. 1900. 8°. 67 pp. 14 pl. Price 15 cents.

171. Boundaries of the United States and of the Several States and Territories, with an Outline of the History of all Important Changes of Territory (Second Edition), by Henry Gannett. 1900. 8°. 142 pp. 53 pl. Price 30 cents.

172. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1899, by Fred Boughton Weeks. 1900. 8°. 141 pp. Price 15 cents.

173. Synopsis of American Fossil Bryozoa, including Bibliography and Synonymy, by John M. Nickles and Ray S. Bassler. 1900. 8°. 663 pp. Price 40 cents.

174. Survey of the Northwestern Boundary of the United States, 1857–1861, by Marcus Baker. 1900. 8°. 78 pp. 1 pl. Price 10 cents.

175. Triangulation and Spirit Leveling in Indian Territory, by C. H. Fitch. 1900. 8°. 141 pp. 1 pl. Price 10 cents.

176. Some Principles and Methods of Rock Analysis, by W. F. Hillebrand. 1900. 8°. 114 pp. Price 15 cents.

In preparation:

— Catalogue and Index of the Publications of the U. S. Geological Survey, 1880–1901, by P. C. Warman.

— Bibliography and Catalogue of the Fossil Vertebrata of North America, by Oliver Perry Hay.

WATER-SUPPLY AND IRRIGATION PAPERS.

By act of Congress approved June 11, 1896, the following provision was made

"*Provided*, That hereafter the reports of the Geological Survey in relation to the gauging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed one hundred pages in length and five thousand copies in number; one thousand copies of which shall be for the official use of the Geological Survey, one thousand five hundred copies shall be delivered to the Senate, and two thousand five hundred copies shall be delivered to the House of Representatives, for distribution."

Under this law the following papers have been published:

1. Pumping Water for Irrigation, by Herbert M. Wilson. 1896. 8°. 57 pp. 9 pl.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis. 1897. 8°. 97 pp. 31 pl.
3. Sewage Irrigation, by George W. Rafter. 1897. 8°. 100 pp. 4 pl.
4. A Reconnoissance in Southeastern Washington, by Israel Cook Russell. 1897. 8°. 96 pp. 7 pl.
5. Irrigation Practice on the Great Plains, by Elias Branson Cowgill. 1897. 8°. 39 pp. 12 pl.
6. Underground Waters of Southwestern Kansas, by Erasmuth Haworth. 1897. 8°. 65 pp. 12 pl.
7. Seepage Waters of Northern Utah, by Samuel Fortier. 1897. 8°. 50 pp. 3 pl.
8. Windmills for Irrigation, by E. C. Murphy. 1897. 8°. 49 pp. 8 pl.
9. Irrigation near Greeley, Colorado, by David Boyd. 1897. 8°. 90 pp. 21 pl.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker. 1898. 8°. 51 pp. 11 pl.
11. River Heights for 1896, by Arthur P. Davis. 1897. 8°. 100 pp.
12. Underground Waters of Southeastern Nebraska, by N. H. Darton. 1898. 8°. 56 pp. 21 pl.
13. Irrigation Systems in Texas, by William Ferguson Hutson. 1898. 8°. 67 pp. 10 pl.
14. New Tests of Pumps and Water-Lifts used in Irrigation, by O. P. Hood. 1898. 8°. 91 pp. 1 pl.
15. Operations at River Stations, 1897, Part I. 1898. 8°. 100 pp.
16. Operations at River Stations, 1897, Part II. 1898. 8°. 101–200 pp.
17. Irrigation near Bakersfield, California, by C. E. Grunsky. 1898. 8°. 96 pp. 16 pl.
18. Irrigation near Fresno, California, by C. E. Grunsky. 1898. 8°. 94 pp. 14 pl.
19. Irrigation near Merced, California, by C. E. Grunsky. 1899. 8°. 59 pp. 11 pl.

20. Experiments with Windmills, by T. O. Perry. 1899. 8°. 97 pp. 12 pl.
21. Wells of Northern Indiana, by Frank Leverett. 1899. 8°. 82 pp. 2 pl.
22. Sewage Irrigation, Part II, by George W. Rafter. 1899. 8°. 100 pp. 7 pl.
23. Water-right Problems of the Bighorn Mountains, by Elwood Mead. 1899. 8°. 62 pp. 7 pl.
24. Water Resources of the State of New York, Part I, by G. W. Rafter. 1899. 8°. 99 pp. 13 pl.
25. Water Resources of the State of New York, Part II, by G. W. Rafter. 1899. 8°. 101–200 pp. 12 pl.
26. Wells of Southern Indiana (Continuation of No. 21), by Frank Leverett. 1899. 8°. 64 pp.
27. Operations at River Stations for 1898, Part I. 1899. 8°. 100 pp.
28. Operations at River Stations for 1898, Part II. 1899. 8°. 101–200 pp.
29. Wells and Windmills in Nebraska, by Erwin H. Barbour. 1899. 8°. 85 pp. 27 pl.
30. Water Resources of the Lower Peninsula of Michigan, by Alfred C. Lane. 1899. 8°. 97 pp. 7 pl.
31. Lower Michigan Mineral Waters, by Alfred C. Lane. 1899. 8°. 97 pp. 4 pl.
32. Water Resources of Puerto Rico, by Herbert M. Wilson. 1899. 8°. 48 pp. 17 pl.
33. Storage of Water on Gila River, Arizona, by Joseph B. Lippincott. 1900. 8°. 98 pp. 33 pl.
34. Geology and Water Resources of SE. South Dakota, by J. E. Todd. 1900. 8°. 34 pp. 19 pl.
35. Operations at River Stations, 1899, Part I. 1900. 8°. 100 pp.
36. Operations at River Stations, 1899, Part II. 1900. 8°. 101–198 pp.
37. Operations at River Stations, 1899, Part III. 1900. 8°. 199–298 pp.
38. Operations at River Stations, 1899, Part IV. 1900. 8°. 299–396 pp.
39. Operations at River Stations, 1899, Part V. 1900. 8°. 397–471 pp.
40. The Austin Dam, by Thomas U. Taylor. 1900. 8°. 51 pp. 16 pl.
41. The Windmill; Its Efficiency and Economic Use, Pt. I, by E. C. Murphy. 1901. 8°. 72 pp. 14 pl
42. The Windmill; Pt. II (Continuation of No. 41). 1901. 8°. 73–147 pp. 15–16 pl.
43. Conveyance of Water, by Samuel Fortier. 1901. 8°. 86 pp. 15 pl.
44. Profiles of Rivers, by Henry Gannett. 1901. 8°. 100 pp. 11 pl.

In press:

45. Water Storage on Cache Creek, California, by A. E. Chandler.
46. Physical Characteristics of Kern River, California, by F. H. Olmsted, and Reconnaissance of Yuba River, California, by M. Manson.
47. Operations at River Stations, 1900, Part I.
48. Operations at River Stations, 1900, Part II.
49. Operations at River Stations, 1900, Part III.
50. Operations at River Stations, 1900, Part IV.

TOPOGRAPHIC MAP OF THE UNITED STATES.

When, in 1882, the Geological Survey was directed by law to make a geologic map of the United States, there was in existence no suitable topographic map to serve as a base for the geologic map. The preparation of such a topographic map was therefore immediately begun. About one-fifth of the area of the country, excluding Alaska, has now been thus mapped. The map is published in atlas sheets, each sheet representing a small quadrangular district, as explained under the next heading. The separate sheets are sold at 5 cents each when fewer than 100 copies are purchased, but when they are ordered in lots of 100 or more copies, whether of the same sheet or of different sheets, the price is 2 cents each. The mapped areas are widely scattered, nearly every State being represented. About 1,100 sheets have been engraved and printed; descriptive circulars concerning them may be had on application.

The map sheets represent a great variety of topographic features, and with the aid of descriptive text they can be used to illustrate topographic forms. This has led to the projection of an educational series of topographic folios, for use wherever geography is taught in high schools, academies, and colleges. Of this series the first three folios have been issued, viz:

1. Physiographic types, by Henry Gannett. 1898. Folio. Four pages of descriptive text and the following topographic sheets: Fargo (N. Dak.-Minn.), a region in youth; Charleston (W. Va.), a region in maturity; Caldwell (Kans.), a region in old age; Palmyra (Va.), a rejuvenated region; Mount Shasta (Cal.), a young volcanic mountain; Eagle (Wis.), moraines; Sun Prairie (Wis.), drumlins; Donaldsonville (La.), river flood plains; Boothbay (Me.), a fiord coast; Atlantic City (N. J.), a barrier-beach coast. Price 25 cents.

2. Physiographic types, by Henry Gannett. 1900. Folio. Eleven pages of descriptive text and the following topographic sheets: Norfolk (Va.-N. C.), a coast swamp; Marshall (Mo.), a graded river; Lexington (Nebr.), an overloaded stream; Harrisburg (Pa.), Appalachian ridges; Poteau Mountain (Ark.-Ind. T.), Ozark ridges; Marshall (Ark.), Ozark Plateau; West Denver (Colo.), hogbacks; Mount Taylor (N. Mex.), volcanic peaks, plateaus, and necks; Cucamonga (Cal.), alluvial cones; Crater Lake special (Oreg.), a crater. Price 25 cents.

3. Physical geography of the Texas region, by Robert T. Hill. 1900. Folio. Twelve pages of text (including 11 cuts); 5 sheets of special half-tone illustrations; 5 topographic sheets, one showing types of mountains, three showing types of plains and scarps, and one showing types of rivers and canyons; and a new map of Texas and parts of adjoining territories. Price 50 cents.

GEOLOGIC ATLAS OF THE UNITED STATES.

The Geologic Atlas of the United States is the final form of publication of the topographic and geologic maps. The atlas is issued in parts, or folios, progressively as the surveys are extended, and is designed ultimately to cover the entire country.

Under the plan adopted the entire area of the country is divided into small rectangular districts (designated *quadrangles*), bounded by certain meridians and parallels. The unit of survey is also the

unit of publication, and the maps and descriptions of each rectangular district are issued as a folio of the Geologic Atlas.

Each folio contains topographic, geologic, economic, and structural maps, together with textual descriptions and explanations, and is designated by the name of a principal town or of a prominent natural feature within the district.

Two forms of issue have been adopted, a "library edition" and a "field edition." In both the sheets are bound between heavy paper covers, but the library copies are permanently bound, while the sheets and covers of the field copies are only temporarily wired together.

Under the law a copy of each folio is sent to certain public libraries and educational institutions. The remainder are sold at 25 cents each, except such as contain an unusual amount of matter, which are priced accordingly. Prepayment is obligatory. The folios ready for distribution are here listed.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
1	Livingston	Montana	110°–111°	45°–46°	3,354	25
2	Ringgold	Georgia Tennessee	85°–85° 30′	34° 30′–35°	980	25
3	Placerville	California	120° 30′–121°	38° 30′–39°	932	25
4	Kingston *a*	Tennessee	84° 30′–85°	35° 30′–36°	969	25
5	Sacramento	California	121°–121° 30′	38° 30′–39°	932	25
6	Chattanooga *a*	Tennessee	85°–85° 30′	35°–35° 30′	975	25
7	Pikes Peak *a*	Colorado	105°–105° 30′	38° 30′–39°	932	25
8	Sewanee	Tennessee	85° 30′–86°	35°–35° 30′	975	25
9	Anthracite-Crested Butte. *a*	Colorado	106° 45′–107° 15′	38° 45′–39°	465	50
10	Harpers Ferry	Virginia West Va Maryland	77° 30′–78°	39°–39° 30′	925	25
11	Jackson	California	120° 30′–121°	38°–38° 30′	938	25
12	Estillville	Virginia Kentucky Tennessee	82° 30′–83°	36° 30′–37°	957	25
13	Fredericksburg	Maryland Virginia	77°–77° 30′	38°–38° 30′	938	25
14	Staunton	Virginia West Va	79°–79° 30′	38°–38° 30′	938	25
15	Lassen Peak	California	121°–122°	40°–41°	3,634	25
16	Knoxville	Tennessee N. Carolina	83° 30′–84°	35° 30′–36°	925	25
17	Marysville	California	121° 30′–122°	39°–39° 30′	925	25
18	Smartsville	California	121°–121° 30′	39°–39° 30′	925	25
19	Stevenson	Alabama Georgia Tennessee	85° 30′–86°	34° 30′–35°	980	25
20	Cleveland	Tennessee	84° 30′–85°	35°–35° 30′	975	25
21	Pikeville	Tennessee	85°–85° 30′	35° 30′–36°	969	25
22	McMinnville	Tennessee	85° 30′–86°	35° 30′–36°	969	25
23	Nomini	Maryland Virginia	76° 30′–77°	38°–38° 30′	938	25
24	Three Forks	Montana	111°–112°	45°–46°	3,354	50
25	London	Tennessee	84°–84° 30′	35° 30′–36°	969	25
26	Pocahontas	Virginia West Va	81°–81° 30′	37°–37° 30′	951	25
27	Morristown	Tennessee	83°–83° 30′	36°–36° 30′	963	25
28	Piedmont	Maryland West Va	79°–79° 30′	39°–39° 30′	925	25
29	Nevada City: Nevada City Grass Valley Banner Hill	California	 121° 00′ 25″–121° 03′ 45″ 121° 01′ 35″–121° 05′ 04″ 120° 57′ 05″–121° 00′ 25″	 39° 13′ 50″–39° 17′ 16″ 39° 10′ 22″–39° 13′ 50″ 39° 13′ 50″–39° 17′ 16″	 11.65 12.09 11.65	50
30	Yellowstone National Park: Gallatin Canyon Shoshone Lake	Wyoming	110°–111°	44°–45°	3,412	75
31	Pyramid Peak	California	120°–120° 30′	44°–45°	932	25
32	Franklin	Virginia West Va	79°–79° 30′	38° 30′–39°	932	25
33	Briceville	Tennessee	84°–84° 30′	36°–36° 30′	963	25
34	Buckhannon	West Va	80°–80° 30′	38° 30′–39°	932	25
35	Gadsden	Alabama	86°–86° 30′	34°–34° 30′	986	25
36	Pueblo	Colorado	104° 30′–105°	38°–38° 30′	938	50
37	Downieville	California	120° 30′–121°	39° 30′–40°	919	25
38	Butte Special	Montana	112° 29′ 30″–112° 36′ 42″	45° 59′ 28″–46° 02′ 54″	22.80	50
39	Truckee	California	120°–120° 30′	39°–39° 30′	925	25
40	Wartburg	Tennessee	84° 30′–85°	36°–36° 30′	963	25
41	Sonora	California	120°–120° 30′	37° 30′–38°	944	25
42	Nueces	Texas	100°–100° 30′	29° 30′–30°	1,035	25
43	Bidwell Bar	California	121°–121° 30′	39° 30′–40°	918	25
44	Tazewell	Virginia West Va	81° 30′–82°	37°–37° 30′	950	25
45	Boise	Idaho	116°–116° 30′	43° 30′–44°	864	25
46	Richmond	Kentucky	84°–84° 30′	37° 30′–38°	944	25
47	London	Kentucky	84°–84° 30′	37°–37° 30′	950	25

a Out of stock.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
48	Tenmile District Special.	Colorado	106° 8′–106° 16′	39° 22′ 30″–39° 30′ 30″	55	25
49	Roseburg	Oregon	123°–123° 30′	43°–43° 30′	871	25
50	Holyoke	Mass.; Conn	72° 30′–73°	42°–42° 30′	885	50
51	Big Trees	California	120°–120° 30′	38°–38° 30′	938	25
52	Absaroka: Crandall; Ishawooa	Wyoming	109° 30′–110°	44°–44° 30′	1,706	25
53	Standingstone	Tennessee	85°–85° 30′	36°–36° 30′	963	25
54	Tacoma	Washington.	122°–122° 30′	47°–47° 30′	812	25
55	Fort Benton	Montana	110°–111°	47°–48°	3,273	25
56	Little Belt Mts	Montana	110°–111°	46°–47°	3,295	25
57	Telluride	Colorado	107° 45′–108°	37° 45′–38°	236	25
58	Elmoro	Colorado	104°–104° 30′	37°–37° 30′	950	25
59	Bristol	Virginia; Tennessee	82°–82° 30′	36° 30′–37°	957	25
60	La Plata	Colorado	108°–108° 15′	37° 15′–37° 30′	237	25
61	Monterey	Virginia; West Va	79° 30′–80°	38°–38° 30′	938	25
62	Menominee Special	Michigan	(a NW.-SE. are , about	22 m. long, $6\frac{1}{2}$ wide)	150	25
63	Mother Lode	California	(a NW.-SE. rectangle,	70 m. long, $6\frac{1}{2}$ wide)	455	50
64	Uvalde	Texas	99° 30′–100°	29°–29° 30′	1,040	25
65	Tintic Special	Utah	111° 55′–112° 10′	39° 45′–40°	229	25
66	Colfax	California	120° 30′–121°	39°–39° 30′	925	25
67	Danville	Illinois; Indiana	87° 30′–87° 45′	40°–40° 15′	228	25
68	Walsenburg	Colorado	104° 30′–105°	37° 30′–38°	944	25
69	Huntington	West Va; Ohio	82°–82° 30′	38°–38° 30′	938	25
70	Washington	Maryland; Dist. of Columbia; Virginia	76° 45′–77° 15′	38° 45′–39°	465	50

STATISTICAL PAPERS.

Mineral Resources of the United States, 1882, by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1887, by David T. Day. 1888. 8°. vii, 832 pp. Price 50 cents.

Mineral Resources of the United States, 1888, by David T. Day. 1890. 8°. vii, 652 pp. Price 50 cents.

Mineral Resources of the United States, 1889 and 1890, by David T. Day. 1892. 8°. viii, 671 pp. Price 50 cents.

Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.

Mineral Resources of the United States, 1892, by David T. Day. 1893. 8°. vii, 850 pp. Price 50 cents.

Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation the following reports have been published:

Mineral Resources of the United States, 1894, David T. Day, Chief of Division. 1895. 8°. xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl. Being Parts III and IV of the Sixteenth Annual Report.

Mineral Resources of the United States, 1895, David T. Day, Chief of Division. 1896. 8°. xxiii, 542 pp., 8 pl. and maps; iii, 543–1058 pp., 9–13 pl. Being Part III (in 2 vols.) of the Seventeenth Annual Report.

Mineral Resources of the United States, 1896, David T. Day, Chief of Division. 1897. 8°. xii, 642 pp., 1 pl.; 643–1400 pp. Being Part V (in 2 vols.) of the Eighteenth Annual Report.

Mineral Resources of the United States, 1897, David T. Day, Chief of Division. 1898. 8°. viii, 651 pp., 11 pl.; viii, 706 pp. Being Part VI (in 2 vols.) of the Nineteenth Annual Report.

Mineral Resources of the United States, 1898, by David T. Day, Chief of Division. 1899. 8°. viii, 616 pp.; ix, 804 pp., 1 pl. Being Part VI (in 2 vols.) of the Twentieth Annual Report.

The money received from the sale of the Survey publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps. All remittances, therefore, must be by MONEY ORDER, made payable to the Director of the United States Geological Survey, or in CURRENCY—the exact amount. Correspondence relating to the publications of the Survey should be addressed to—

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *April*, 1901.

O